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Oil and Gas Geology of the Warren Quadrangle, Pennsylvania

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Oil and Gas Geology of the Warren Quadrangle, Pennsylvania

by William S. Lytle
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OIL AND GAS GEOLOGY OF THE WARREN QUADRANGLE, PENNSYLVANIA

by William S. Lytle

ABSTRACT

This study of the oil and gas geology of the Warren quadrangle is a part of the program to report continuing detailed investigations of the oil and gas fields of the Commonwealth. Recent drilling in the Glade sand area of the quadrangle and the success of hydraulic stimulation prompted the publication of a preliminary report on Warren 7½-minute quadrangle and a decision to publish this report of the 15-minute quadrangle in the near future. This study is restricted to the Upper Devonian sands that contain oil. These sands in order of their economic importance are: Clarendon, Glade, Gartland, Clarendon Stray, and Cherry Grove sands.

Hundreds of well records were collected along with the well locations in the Warren quadrangle. The wells were located on a 7½-minute base map containing the most recent property information. The available water flooding and production data, geophysical logs, and drill cuttings were collected. For completeness a general discussion on the surface stratigraphy is included which is based primarily on an earlier report by Butts published in 1910. Twelve deep wells (Middle Devonian or older) in the quadrangle are summarized in the text. The deepest well reached the Upper Cambrian.

Air or gas drive or a combination of the two have had some success as a secondary method of producing oil in the quadrangle. Widespread water flooding in the southern part of the Clarendon Pool has recovered up to 2500 barrels per acre from some projects. Hydraulic stimulation and notching have proved economical in the Glade and Clarendon sands. The use of these completion techniques should become widespread within the quadrangle in the near future. The report suggests that three areas within the quadrangle may yet be developed.

INTRODUCTION

The Warren 15-minute quadrangle is located entirely in Warren County of northwestern Pennsylvania (Figure 1). The quadrangle covers about 222 square miles and lies between 41°45′ and 42°00′ N. latitude and 79°00′ and 79°15′ W. longitude. About one third of the quadrangle is productive of oil and gas. The main producing sands are the Glade, Clarendon Stray, Clarendon, Gartland, and Cherry Grove of Upper Devonian age. The accumulation of oil and gas is controlled principally by stratigraphic factors.

Well records and locations were collected on the oil and gas fields in the quadrangle by S. H. Cathcart (deceased) and T. H. Jones in the late thirties to be published in a report such as this. In the mid-forties W. H. Seifert collected additional data bringing the field work up to date. The author with the assistance of Wayne S. Leeper and Daniel F. Balsinger

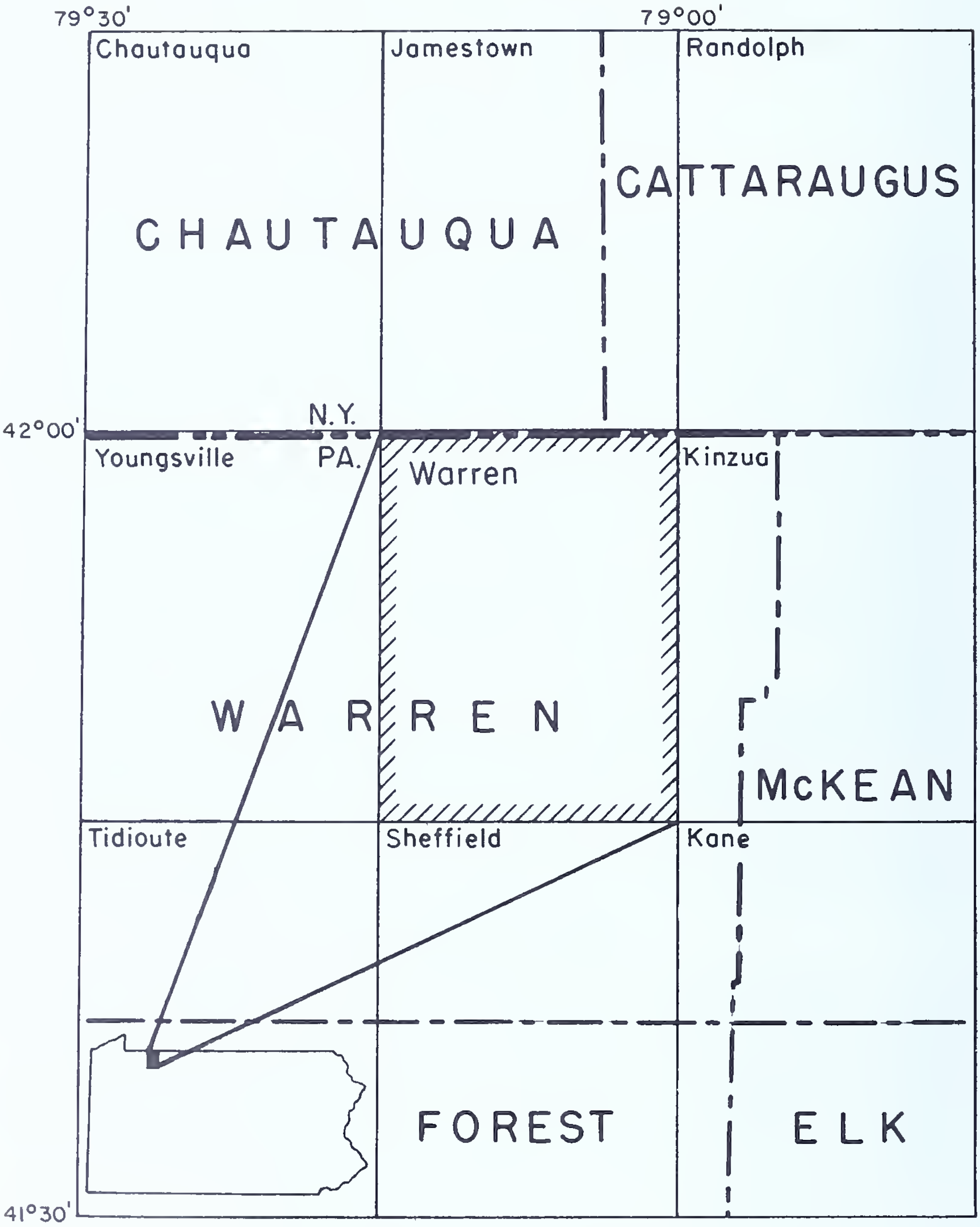


FIGURE 1. Index map showing location of Warren quadrangle

again brought the field work up to date in the late fifties. Recent drilling activity in the Glade sand area of the quadrangle prompted publication of a preliminary report on the Warren 7½-minute quadrangle (Lytle, 1963) and a decision to publish this report on the 15-minute quadrangle with very little additional field work. Geophysical logs and drill cuttings were obtained in the last two years from the local producers to aid in the discussion and interpretation of the subsurface geology.

PURPOSE OF INVESTIGATION

This study of the oil and gas geology of the Warren quadrangle is a part of the program to continue detailed investigations of the oil and gas fields of the Commonwealth. Many of these detailed reports have been published mainly as quadrangle reports.

The purposes of the detailed reports are 1) to make as much data as possible available to the producer so it can be used in the secondary recovery of oil, 2) to help the operator find new production, 3) and to learn more about the origin, migration, and accumulation of oil and gas.

Water flooding and air and gas injection are secondary recovery methods which have been in operation in the area for several years. Information contained in this report may be of help in increasing the use of secondary recovery in the area. In the last few years new interest has been directed toward the Glade and Clarendon sands, both of which have responded to stimulation by hydraulic fracturing.

Producers need the kind of material published in this report to expand their operations. If any one of the new tertiary methods of oil recovery such as in-situ combustion, miscible displacement, and steam flooding prove economical, the information contained in this report will be of value to producers.

METHOD OF INVESTIGATION

Property line maps for Warren County were completed in 1958. The current property lines were used since they were more accurate than the ones available when the well locations were made. Transferring well locations from old maps to the new ones introduces a slight inaccuracy because of the difficulty of determining the exact location of a given well where a property had been sub-divided or increased. There was no opportunity to recheck the well locations in the field.

The map well numbers which are underlined indicate that drillers' records are available in the files of the Pennsylvania Geological Survey; numbres not underlined indicate no record available. An underlined sand symbol on the map indicates no information available other than type of well.

The culture and streams shown on the map are based on the U. S. Geological Survey 7½-minute quadrangle series. The land subdivisions were compiled from the Warren County Real Estate Assessment System maps (1958) and aerial photographs from the Pennsylvania Department of Commerce (1950); The Allegheny Forest lots from the U. S. Department of Agriculture Allegheny Forest and Purchase Unit map of 1942.

All the wells known to have been drilled for oil and gas in the quadrangle are shown on the map. Well locations were mostly obtained by interview with individuals familiar with the area, coupled with extensive field work, and from oil and gas lease and property maps. A name in upper case letters beside the symbol for a well or group of wells is the only name known, and may be either the name of the property owner or the well operator. A number has been assigned to each well on a given property. Since this number may or may not be the original well number, it is pertinent only in reference to this report. The original wells on some leases have been plugged and the entire lease laid out in a five spot flood pattern and drilled. Only the water input wells are shown in such cases because the wells are so closely spaced that they would not show up clearly on the published map. In Appendix C (selected well records) the original well ownership and well number, when available, are given.

The accompanying map shows 5366 wells in the quadrangle. Drillers' logs were obtained from the majority of the wells. The logs in most cases only report the top and bottom of the producing interval.

For historical record and as a basis for evaluation of future activity, a detailed log should be recorded for *every* well drilled. This plea for accurate record keeping is not new; it is the echo of every petroleum geologist and engineer in the Appalachians. In fact it was first stressed by John F. Carll, pioneer petroleum geologist, in volume I3 of the Second Geological Survey of Pennsylvania.

The recent success of stimulation by hydraulic fracturing in the Warren area brought into use the modern geophysical logging and completion techniques. The producers made the geophysical logs available to the Survey and they have been used extensively in the published cross sections. The logs made available were the spontaneous potential, guard, gamma ray, neutron, caliper, temperature, and density records.

Elevations were obtained on a large portion of the wells by the altimeter method. A few of the elevations were determined with alidade. Most of the elevations are correct within 10 feet while a few may be as much as 20 feet in error. Six complete and several partial sets of drill cuttings have been collected from wells in the quadrangle. A description of one set of samples is published in the appendix. Producers in the area made additional drill cuttings available to the Survey. Numerous core analyses were also made available.

A total of 12 deep wells have been drilled in the quadrangle. A deep well is one that has been drilled below the Tully Limestone. The records of the deep wells can be seen in Table 1. None of the deep wells have produced oil or gas in commercial quantity.

ACKNOWLEDGMENTS

Operators, interested individuals, and service companies, almost without exception, willingly contributed their time and data. It is impossible to list all the many sources of information. We particularly wish to acknowledge the cooperaton given us by D. W. Franchot and Company, Inc.; Pennzoil Company; Oil and Gas Division, Pennsylvania Department of Mines and Mineral Industries; and United States Bureau of Mines.

Miss Lillian Heeren of the Bureau of Topographic and Geologic Survey drafted the plates and figures.

TOPOGRAPHY

DRAINAGE

The Warren quadrangle lies within the Allegheny Plateau physiographic province. The area is drained by the Allegheny River which crosses the quadrangle in the southern half, flowing westward from Big Bend to Irvine.

The northern part of the quadrangle is drained by the southward-flowing Conewango Creek which joins the Allegheny River at Warren. In the southern part of the quadrangle considerable drainage is to the north through Morrison, Dutchman, and Browns Runs. In the extreme southern part of the quadrangle the Tionesta Creek flows northwestward to Clarendon, within 4 miles of the Allegheny River, and then, instead of continuing northward along the wide valley of Dutchman Run to Glade, it turns southward and joins the Allegheny at Tionesta 20 miles southwest of the quadrangle. The course of Tionesta Creek was determined by the action of the glaciers described later in the text.

RELIEF

The topography of the quadrangle is that of a mature, dissected plateau. The surface is very hilly with numerous short ridges and spurs which have no systematic orientation. Most of the ridges are rather broad and comparatively level on top. The main valleys are deep and narrow, bounded by steep walls. In the northwestern part of the quadrangle the slopes are more gentle due to smoothing action by the ice during glacial time. Glacial activity also caused partial filling of the valleys forming wide bottom land and terraces in the valleys of the larger streams. Gravel terraces exist at two levels along the Allegheny River. At Warren the upper terrace lies at 1370 feet above sea level and the lower terrace, on which the borough of Warren is built, lies at 1200 feet above sea level. An old peneplained erosion surface, which has been uplifted and dissected, is suggested by the general uniformity in elevation of the highest hills.

The highest surface elevation in the quadrangle is in Elk Township a mile northeast of Clendening Corners where the top of the hill is 2231 feet above sea level. The lowest surface elevation is about 1149 feet where the Allegheny River leaves the quadrangle at Irvine. Most of the area is heavily forested.

GLACIATION

During the Ice Age northwestern Pennsylvania was covered by continental ice sheets which invaded from the north and northwest (Shepps and others, 1959). The ice sheets advanced twice into the quadrangle during the Pleistocene Epoch. The first advance was during Illinoian time. The ice covered the northwestern quarter of the quadrangle as far south as the city of Warren. The evidence of this advance can be seen in the thin discontinuous weathered till blanket that covers the area. The second advance into the quadrangle was the Kent advance during the Wisconsin Stage. The ice did not come as far south as before, stopping along a line roughly from Putnamville to Russell, then along Ackley Run for about three miles and then north to the edge of the quadrangle on a line passing between Cable Hollow and Clendening Corners. The evidence of the Kent advance can be seen in the ground and end moraine of sandy loam.

Other evidence left by the meltwaters of the glaciers are the kames, kame terraces, kame moraines, and eskers made of sand and gravel that were deposited along Conewango Creek, Jackson Run and at the confluence of Conewango Creek and the Allegheny River. Also outwash river terraces of sand, silt, and clay are present along Conewango Creek, Jackson Run, Allegheny River, Dutchman Run, and Tionesta Creek. During glacial time the waters from Dutchman Run flowed south into Tionesta Creek until the flow of water decreased and the stream bed at Clarendon became clogged with silts and clays. Now Dutchman Run flows north into the Allegheny River.

STRATIGRAPHY

GENERAL STATEMENT

A geologic atlas of the Warren quadrangle was prepared by Charles Butts and published by the U. S. Geological Survey (Butts, 1910). The Warren atlas presents a detailed report of the surface stratigraphy, but since the atlas is out-of-print, and in order to show the complete geologic column, general discussion on the surface stratigraphy is repeated in this report.

The term "sand" as used in this report and as commonly understood by oil and gas drillers and operators refers to a potentially productive zone which in most cases comprizes sandstone with intimately associated siltstones and shales. The term "rocks" as used in this report after the name of a producing unit is more inclusive than the term "sand" and includes transitional zones above and below the producing zone. The term "sandstone" is used to refer only to beds of lithified sand.

SURFACE STRATIGRAPHY

Covering the northwestern quarter of the quadrangle are the unconsolidated clay, silt, sand, and gravel sediments resulting from glaciation. Below these sediments and outcropping in the other three quarters of the quadrangle are rocks totalling 1040 feet in thickness which belong to the Pennsylvanian, Mississippian, and Devonian Systems. About 480 feet of these rocks are Pennsylvanian and Mississippian. The best outcrops are found near the hill tops or in road cuts. Very often they have been covered over by erosion on the slopes and in the valleys. The succession of surface rocks consists of beds of shale, siltstone, sandstone, and conglomerate.

Pennsylvanian System

The rocks of Pennsylvanian age in the Warren quadrangle consist of massive coarse white sandstones and conglomerates with interbeds of soft dark shales containing limonite nodules and an occasional thin bed of coal. The massive sandstones and conglomerates of this age cap the ridge northeast of Smith Corners, the ridge south of Hodge Run and north of the Allegheny River, and several ridges south of the river.

Pottsville Group

The only rocks of the Pennsylvanian System in the quadrangle are those in the Pottsville Group. Younger Pennsylvanian rocks have been entirely eroded away. Pottsville rocks have been removed from more than two thirds of the area by erosion. They are preserved only on the highest ridges south of the Allegheny River and cap high points north of the river in the east-central part of the quadrangle. The maximum thickness of Pottsville rocks remaining in the quadrangle is 200 feet; this includes the Connoquenessing and Sharon Formations and the Olean Conglomerate. The units are listed below with their approximate thicknesses.

Pennsylvanian System		
Pottsville Group		200 feet
Connoquenessing Formation	100 feet	
Sharon Formation	50 feet	
Olean Formation	50 feet max.	
Unconformity		

Connoquenessing Formation

The Connoquenessing Formation is the youngest of the Pottsville rocks in the quadrangle. It is a very coarse, white quartz sandstone with a few small pebbles. The maximum thickness of this sandstone in the quadrangle is about 100 feet, just south of the Allegheny River near Big Bend.

Sharon Formation

The Sharon Formation is a dark fissile shale with thin coal and limonite nodules and a few thin sandstone layers. It occupies the interval between the Connoquenessing Formation and the Olean Conglomerate.

Olean Conglomerate

The Olean Conglomerate lies immediately above the erosional unconformity at the top of the Mississippian rocks and attains a maximum thickness of 50 feet where it has filled depressions in the erosion surface. The Olean is a massive coarse conglomerate of well-rounded pebbles of white vein quartz ranging up to 2½ inches in diameter. The pebbles are surrounded by quartz grains and cemented with iron oxide and silica. The roundness of the pebbles distinguishes them from the disk-shaped pebbles of the underlying Knapp conglomerate (Mississippian).

About 2 miles southeast of Scandia a coal bed underlies the Olean Conglomerate. It is probably the same as the lower Marshburg coal bed of McKean County. It is about 2 feet thick and has been mined over an area of about 50 acres, its maximum extent. The coal bed was apparently laid down unconformably on the eroded surface of the Knapp Formation.

Pennsylvanian-Mississippian Unconformity

The Pottsville Group of the Pennsylvanian rests unconformably upon rocks of the Mississippian System. The rocks below the unconformity were tilted southward, probably folded slightly, and truncated by erosion before the Pottsville Group was deposited. A result of this unconformity is that strata in actual contact are different in different localities. The Mississippian beds encountered immediately below the unconformity become progressively younger from north to south in the quadrangle.

Mississippian System

The Mississippian strata range in thickness from about 280 feet along the southern margin of the quadrangle to zero north of Jackson Run and west to the Conewango Creek. This thinning and truncation are erosion which occurred prior to the onset of Pennsylvanian deposition. This section includes the Knapp Formation. Although the Knapp was considered to be Devonian in the earlier study of this area by Butts (1910), it was later shown on additional paleontologic evidence to be Mississippian.

Description of Strata

The Mississippian rocks of this quadrangle in descending order are the Cuyahoga Formation, Berea Sandstone, and Knapp Formation. They are listed below with their typical thicknesses.

Mississippian System		280 feet
Cuyahoga Formation	195 feet	
Berea (Corry) Sandstone	5 feet	
Knapp Formation	80 feet	

Cuyahoga Formation

This formation consists of dark-bluish-gray sandy shales, thin fine-grained sandstones which are sometimes argillaceous, and thin conglomerate layers with small flat pebbles. It varies in thickness from a few feet north of the Allegheny River to more than 200 feet at the south margin of the quadrangle, this gradual thickening southward being due to the unconformity at the top of the formation.

Berea Sandstone

The Berea (Corry) Sandstone is thin, fine-grained, yellow to light-brown, and very fossiliferous. It varies in thickness from 2 to 5 feet. Many loose pieces of the sandstone crowded with its fossils have been found at many points in the quadrangle immediately overlying the Knapp Formation.

Knapp Formation

The Knapp Formation is composed of three members and attains a maximum thickness of about 120 feet. The top member is a conglomerate 20 to 60 feet thick, the middle member is a bed of shale and thin fine-grained sandstone 10 to 40 feet thick and the bottom member is a conglomerate 20 to 30 feet thick.

The upper member is a dense conglomerate with small flat quartz pebbles ½ inch or less in the largest dimension and varies from yellow to brown in color, weathering white. It reaches a maximum thickness of 100 feet on a hill a mile north of Clendening Corners and thins to probably less than 20 ft. at Sill Run where it is mainly sandstone. The middle shale member is yellowish green, micaceous, and sandy or clayey and contains thin layers of yellowish-green argillaceous sandstone. It is thickest in the southwest and thinnest in the northeast.

The lower member contains very small iron-stained quartz pebbles in a matrix of ferruginous sand. In places it is almost entirely composed of pebbles. This lower fossiliferous unit contains crinoid stems and brachiopods. In places the bed becomes a coarser and more resistant conglomerate. This lower member can be seen as isolated patches on the knobs along the ridge between the river and Jackson Run. It is present along the northeastern margin of the quadrangle, thinning below the river to the west. At Big Bend the middle shale member has disappeared and the two conglomerate members converge to make a single member 80 feet thick.

Devonian System

Approximately 770 feet of Upper Devonian rocks are exposed in the topographically low areas of the quadrangle. Approximately the upper 450 feet of this section is included in the Conewango Group and the bottom 320 feet in the Conneaut Group. The rocks of the Conewango Group will be discussed under surface stratigraphy whereas the entire Conneaut Group will be discussed under subsurface stratigraphy.

The Upper Devonian in this report includes in descending order the Conewango, Conneaut, and Canadaway Groups which will be discussed in detail. The thick Upper Devonian sequence of rocks below the Canadaway will be briefly mentioned under Deeper Exploration.

Conewango Group

In the Warren atlas Butts (1910) did not subdivide the Conewango Group. But the group is divided here into the Riceville and Cattaraugus Formations since it was felt that enough evidence was available in the well samples and mechanical logs to make this division. Also

	Thickness in Feet
Devonian System	
Upper Devonian	3655
Conewango Group	450
Riceville Formation	100
Cattaraugus Formation	350
Conneaut Group	790
Shale and siltstone	120
"Pink Rock"	345
Warren First sand	30
Shale and siltstone	70
Warren Second sand	25
Shale and siltstone	45

Unnamed sandstone	10
Shale	20
Top Glade rocks (shale and siltstone)	25
Glade "siltstone"	40
Glade "sandstone"	20
Glade transitional zone	40
Canadaway Group	1600
Clarendon Stray sandstone zone	40
Clarendon sandstone	30
Shale and siltstone	10
Gartland sandstone	15
Shale and siltstone	40
Cherry Grove sandstone	15

The interval from the base of the Cherry Grove sandstone to the top of the Tully limestone, which is the base of Upper Devonian, consists of shales and siltstones with a thickness of 2265 feet.

these terms are in general usage in northwestern Pennsylvania and have been used in the current publications. The base of the group is the base of the Tanners Hill Member instead of the top of the "Pink Rock" as used by Butts.

Riceville Formation

This formation is mostly light-greenish-gray to light-bluish-gray shale with some very fine-grained greenish-gray to yellowish-brown sandstone. The Riceville ranges in thickness from about 80 feet in the western part of the quadrangle to 120 feet in the eastern part. It is present in outcrop over the entire quadrangle except in the northwestern quarter where it has been removed by erosion.

Cattaraugus Formation

In this report the Cattaraugus Formation includes the rocks between the base of the Riceville Formation, which is the top of the Venango First sand zone, and the base of the Tanners Hill red rock. As thus defined the average thickness is about 350 feet. The formation consists of the Venango First sand zone, the Red Valley and Lytle sand zone, the Venango Second sand zone, the Venango Third and Knox sands, and the Tanners Hill Member. These sands are highly productive of oil and gas to the southwest of the Warren quadrangle. Within the quadrangle only shows of oil and gas have been reported occasionally from the Venango Second and Third sand zones. The only well-developed unit within the Cattaraugus Formation is the Venango Second sand which corresponds closely in stratigraphic position to the Salamanca conglomerate (Fettke, 1938, p. 35).

The Cattaraugus Formation consists mainly of greenish-gray siltstones and shales, in part micaceous and friable, with thin layers of very fine-grained, light-greenish-gray sandstones which are somewhat calcareous.

Occasional layers of coarse-grained to conglomeratic sandstones are present. The Venango Second sand lies about 290 feet above the "Pink Rock" and varies in thickness from 10 to 20 feet. The rocks both above and below the Venango Second sand are light-gray to greenish-gray, flaggy sandstones. The sand sequence makes a deposit approximately 50 feet thick. The Venango Second sand varies from a coarse conglomerate to a medium-grained, medium-thick-bedded, rather soft sandstone. It is generally white to gray to greenish-gray in color. The pebbles are of quartz, under one inch in the longest diameter, and are flat. The Venango Second sand is at or near the base of the "Big Red Rock," a red shale and siltstone section whose top is approximately 315 feet above the "Pink Rock" or 165 feet above the Tanners Hill Member as logged by the driller. The Venango Second sand and a sand just above the Tanners Hill Member are generally referred to by the drillers as the Clarion sand. The Tanners Hill Member is one of the most persistent lithologic units in the quadrangle. It is a 15- to 40-foot bed of red shale and siltstone just below the Knox Fifth sand. The type locality is the Tanners Hill quarry in Warren. The top of the Tanners Hill Member lies approximately 150 feet above the "Pink Rock."

SUBSURFACE STRATIGRAPHY

Upper Devonian Series

Conneaut Group

The Conneaut Group in the quadrangle is mostly shale and siltstone with several units of sandstone near its base. One of these sands is an important producer of oil in the quadrangle. The group includes, in descending order, a 120-foot shaly section, the "Pink Rock," Warren First sand, Warren Second sand, and Glade rocks. The Conneaut Group is approximately 790 feet thick. The section just below the Tanners Hill Member to the top of the "Pink Rock" consists of approximately 120 feet of shale and siltstone with occasionally a 10- to 20-foot bed of very-fine-grained, greenish-gray sandstone at the top of the section. This sandstone lies near the horizon of the Wolf Creek Conglomerate as described by Glenn (1903).

"Pink Rock"

The "Pink Rock" is also a persistent lithologic unit in the quadrangle both on the surface and in the subsurface. Along Conewango Creek in the extreme northern part of the quadrangle approximately 200 feet of "Pink Rock" is exposed. Its total thickness averages 345 feet. This rock unit is present over the entire quadrangle and is therefore an excellent horizon for mapping, especially its base, but the drillers fail to regularly record the "Pink Rock" on their logs. It is found east to McKean County and west to Venango County. To the west in the Youngsville quadrangle it also averages 345 feet thick while to the south in the Sheffield quadrangle the thickness was never found to be less than 346 nor more than 356 feet. The "Pink Rock" remains fairly constant in its lithology throughout the quadrangle. It consists of purplish-gray to reddish-gray siltstones and shales with some interbedded greenish-gray siltstones and shales. It is very fossiliferous containing brachiopods and crinoid columnals. The fossils occur mostly near the top of the "Pink Rock," in the middle, and near the base. Occasionally a fourth fossiliferous zone is found between the middle and basal fossiliferous zones. The top and bottom of the "Pink Rock" can easily be picked on a gamma-neutron log.

Warren First Sand

Immediately below the base of the "Pink Rock" lies the Warren First sand. It is an interbedded very fine-grained, greenish-gray sandstone and olive-gray siltstone with some greenish-gray shale. The Warren First sand is productive of a little oil on the John M. Hunter farm (Index no. H-9). It is erroneously called the Chipmunk sand. The true Chipmunk sand is correlative with the Cherry Grove sand (Fettke, 1938, p. 98). In the Warren quadrangle the Warren First sand is poorly developed, being composed mostly of siltstone and shale. It averages 30 feet in thickness and varies from 40 feet in thickness in the northwestern corner of the quadrangle to 25 feet in the southeastern corner. In the sheffield quadrangle (Ingham, 1956, p. 22) it has a thickness of 0 to 15 feet while in the Youngsville quadrangle (McGlade, 1964, p. 10) its thickness is 38 feet along the eastern portion of the quadrangle and thinner to the northwest. The section below the base of the Warren First sand to the top of the Warren Second sand consists of interbedded greenish-gray to brownish-gray siltstones and shales. The base of the Warren First sand being easily recognized on a gamma-neutron log is a good marker for correlation. Cross-section E-A′ (Plate 4) of this report has this horizon as its datum line.

Warren Second Sand

The Warren Second sand contains considerably more sand than the Warren First sand. The sand is fine- to medium-grained and locally pebbly. It is light-greenish- to yellowish-gray in color. Its thickness is a fairly uniform 25 feet over the entire quadrangle. The top of the sand lies about 100 feet below the base of the "Pink Rock." Several wells in the quadrangle have reported shows of oil and gas from the unit but no commercial production from this sand has been found in the quadrangle. Small amounts of gas production have been obtained from this sand from wells in the Sheffield quadrangle. Also, in the Tidioute quadrangle

(Cathcart, 1938, p. 12) is located a Warren Second sand pool, two miles east of the town of Tidioute, which has produced small amounts of oil and gas. The interval from the base of the Warren Second sand to the top of the Glade rocks is predominately greenish-gray shale with some interbedded greenish-gray siltstone. About 30 feet above the Glade rocks is an unnamed sandstone which is quite persistent over large areas. It is approximately 10 feet thick. Shows of oil have been reported from it. It is easily recognized on geophysical logs.

Glade Rocks

The top of the Glade rocks lies at approximately 200 feet below the base of the "Pink Rock" or 75 feet below the base of the Warren Second sand. The Glade rocks extend about 125 feet to the top of the Clarendon rocks. The base of the Glade rocks is also the base of the Conneaut Group and the top of the Canadaway Group. The Glade rocks are, for the purpose of this report, divided into three persistent lithologic units from about 25 feet below the top and extending to the base of the Glade rocks. The units are the Glade siltstone, Glade sand (the producing zone), and the Glade transitional zone. These are the same units as used in the Youngsville report and defined by McGlade (1964) except for the Glade siltstone unit which has been slightly modified. The type section in the Morrison Run Field can be seen on Plates 6 and 7 (well 013) and is described in Appendix A. The 25 feet of greenish-gray siltstone and shale between the top of the Glade rocks and the top of the Glade siltstone varies in thickness and composition, but because of a high silt content is more correctly placed within the Glade rocks than with the unit above.

The top of the uppermost persistent lithologic unit, the Glade siltstone, of the Glade rocks is the beginning of a silty section about 100 feet below the Warren Second sand. It is predominantly a greenish-gray slightly calcareous, argillaceous siltstone which contains fossils, and some interbedded greenish-gray shale. The Glade siltstone is about 40 feet thick. In areas where the Glade sand reaches its maximum thickness, it extends upward into and replaces part of the Glade siltstone (Plate 6). The only place this was observed was in the Morrison Run area where the Glade sand is at its maximum development. Over most of the oil and gas producing area of the quadrangle the Glade siltstone is a consistent lithologic unit. The top of the Glade siltstone can readily be determined from sample examination and on geophysical logs. The top of this unit is quite often reported as the top of the Glade sand by the drillers.

The middle zone of the Glade rocks is the Glade sand which is one of the main producing zones in the Warren quadrangle. The Glade sand in the area of maximum development occupies almost the entire thickness of the Glade transitional zone below and part of the Glade siltstone above (Plate 6). The Glade sand attains a maximum thickness of approximately 60 feet in the Morrison Run area. According to McGlade (1964) the sandstone units of the Glade rocks disappear progressively from bottom to top into shale and hence "climb" in the section going westward from Warren into the Youngsville area. The base of the sandstone also climbs in an easterly direction from the area of maximum development in the Morrison Run area (Plates 5, 7, and 8). There are exceptions as shown in a new well drilled on Lot 490 in Pleasant Township where the upper part of the Glade is shale and siltstone and the oil productive unit is near the base of the Glade transitional zone. The top of the Glade sand ranges from 210 to 240 feet below the base of the "Pink Rock" and averages 225 feet.

The Glade sand is mostly a very fine- to fine-grained, light-gray sandstone. In some areas where productive it is a greenish-gray siltstone. It is also slightly micaceous and calcerous. Occasionally a zone of fossil fragments can be found in the middle of the sandstone.

In general the basal part of the Glade sand is a silty, very fine-grained, light-gray sandstone. The sand becomes coarser progressively upward in the sand body to a fine-grained and occasionally a medium-grained rock. In Warren Borough the top of the unit may be very coarse grained. The highest initial open flows occurred in this area, probably because of the coarse permeable sand at the top of the unit. This is also the case where the sand is productive in East Warren and Glade sections of the borough of Warren where it first produced in the Beatty No. 1 well (Plate 1, Index G9). This productive unit was first called Glade sand in this quadrangle.

The Glade sand correlates with the base of the Queen zone in the Tidioute quadrangle. It also possibly correlates with the Bradford First sand of McKean County and the Cuba sandstone (Fettke, 1938, p. 147) of Cuba, Allegheny County, New York. Although the Glade sand of the Youngsville quadrangle and the basal Queen zone in the Tidioute quadrangle probably lie in the same stratigraphic interval, they are separated from each other by changes in permeability and lithology.

The Glade sand of the Warren quadrangle appears to have been deposited in a trough or depression which trends slightly east of north from the middle of the Morrison Run Field through the center of the Warren Field to the north. If this is correct there is considerable acreage between the two fields where a 40- to 50-foot thickness of Glade sand is probably present. This trend might continue southwest of the Morrison Run Field.

Plate 4 shows a full-hole, cross-sectional slice from the northwestern corner to the southeastern corner of the quadrangle. The section clearly shows that all of the units that produce oil and gas in the central and southeastern section of the quadrangle are poorly developed and nonproductive in the northwestern area. To the southeast the units become well developed and productive as in the case of the Glade sand. Well No. 22 shows a well-developed Glade sand unit whose top remains constant but whose base becomes shale in a southeasterly direction. Plates 5, 6, 7, and 8 show that the Glade sand is not a massive bed of sand but is composed of units of interbedded sandstone, siltstone, and shale. Generally the driller records it as one unit and does not show the individual units that can be seen on the geophysical log. A driller will also record the top of the Glade sand at a different depth from other drillers. Because of the variations by drillers in recording the depths and thicknesses of various units, isopachous and structure maps based on drillers' reports of Glade sand or any other producing unit do not represent an accurate stratigraphic and structure picture and such maps are not included in the report.

The Glade transitional zone, the basal unit of the Glade rocks, includes all the rocks between the base of the Glade sand and the top of the Clarendon rocks (Plates 4, 5, 6, 7, 8) which is also the top of the Canadaway Group. The top of the Glade transitional zone occurs at the base of the Glade sand where the lithology changes from a predominately sandstone-siltstone unit to a unit composed mostly of dark-gray shale. The contact point between the two units is an arbitrary point and is generally determined by inspection of the geophysical logs. If very fine-grained sandstones and siltstones are included in the top of the unit, their occurrence decreases from top to bottom. As the term Glade transitional zone suggests, the zone is gradational with the Glade sand. Therefore as the sandstone beds in the top of this transitional zone become incorporated into the basal Glade sand, the Glade transitional zone decreases in thickness. The transitional zone varies from 15 to over 60 feet in thickness. It is thinnest in the middle of the oil fields and thickest between the oil fields and at their edges.

Canadaway Group

In the Warren quadrangle the Canadaway Group is approximately 1600 feet thick. Four sands in this group are productive in the quadrangle. They are, in descending order, the Clarendon Stray, Clarendon, Gartland, and Cherry Grove.

Clarendon Stray Sand

Between the base of the Glade rocks and the Clarendon sand is the zone of Clarendon Stray sand. The zone is approximately 40 feet thick. The top of the zone generaly consists of about 20 feet of medium-gray shales and siltstones with rare fine-grained sandstone (Plates 5, 6, 7, 8).

When the siltstones and sandstones are well developed in the lower 20 feet of the zone and are productive of oil and gas, the productive zone is called the Clarendon Stray sand. The Clarendon Stray sand is a very fine- to fine-grained, light-gray sandstone. The sand is productive of gas along the Allegheny River near Big Bend (Plate 1). Occasionally the driller will report a Clarendon sand thickness which includes the Clarendon Stray sand. A number of drillers' logs show the Clarendon Stray sand separated from the Clarendon sand by one-foot-thick fossiliferous cap rock. The top of the zone of Clarendon Stray sand is the top of the Clarendon rocks. The top of these rocks lies about 310 to 330 feet below the "Pink Rock," the average interval being 325 feet.

Clarendon Sand

The Clarendon is the main oil-producing sand in the quadrangle. The limits of the producing area continue to the south into the Sheffield quadrangle where this sand is one of the most important producers. The true main body of Clarendon sand is more uniform than the other oil and gas producing sands in the quadrangle. It is a very fine-grained to pebbly, light-greenish-gray sandstone varying in thickness from 0 to 50 feet, averaging 30 feet. It contains very little interbedded shale. In its productive area it has one foot to an occasional eight feet of cap rock at the top, below which gas and then oil is found in the upper 10 feet. The sand is free from salt water. When the Clarendon Stray sand is included with the Clarendon sand the interval from the base of the "Pink Rock" is 345 feet, whereas the interval from the base of the "Pink Rock" to the top of the true Clarendon sand is 365 feet.

The Clarendon sand is best developed in the southeastern section of the quadrangle where the main producing belt attains a width of over five miles. The Clarendon sand is frequently logged as "Third" and "Tiona" by the drillers. Its base, which is also the base of the Clarendon rocks, is hard to determine. If the Gartland sand below is well developed, the top of the Gartland is considered to be the base of the Clarendon rocks (Plate 7). When the base of the Clarendon rocks can be picked on the geophysical logs the lower unit of those rocks is called the zone of Clarendon sand. The zone contains the Clarendon sand at its top, if developed, and shales and siltstones below. It is approximately 40 feet thick.

Gartland Sand

The Gartland Pool, located in the Glade area and extending to the southwest to Morrison Run, produces from the Gartland sand which lies 40 to 50 feet below the top of the Clarendon sand. The Gartland is a fine- to coarse-grained, white pebbly sand approximately 15 feet thick.

The Gartland sand is productive in only the one area described above. It lies approximately 405 feet below the "Pink Rock." This long narrow productive streak trending northeast and southwest appears to have been laid down as a sand bar along a shore line.

Cherry Grove Sand

Approximately 460 feet below the "Pink Rock" lies the top of the Cherry Grove sand. Between it and the Gartland sand above are 40 feet of greenish-gray siltstones and dark-gray shale. The Cherry Grove sand produces in the Cherry Grove Field of the Sheffield quadrangle. A very small portion of this field extends across the line into the south-central part of the Warren quadrangle. In the area of the quadrangle where it is productive, the Gartland sand is not developed, and the interval from the top of the Cherry Grove sand to the base of the Clarendon sand, an interval of 60 feet, consists of siltstones and shales. The Cherry Grove sand was named for the village and township of Cherry Grove. The thickness of the sand varies from 0 to 40 feet and averages 15 feet. It is a very fine- to coarse-grained, light-gray sandstone. It has been correlated with the Gartland sand in this quadrangle but it is the author's belief that the Cherry Grove sand was deposited at an earlier time than the Gartland sand and the sands have been miscorrelated.

DEEP EXPLORATION

Upper Devonian Series below the Canadaway Group

A number of wells in the quadrangle have been drilled several hundred feet below the Cherry Grove sand in search of oil and gas production. Most of these wells found only shows, nothing in commercial quantity. In the late 1800's a few wells in the North Warren Field produced oil from a sand correlative with the Cooper (570 feet below the base of the "Pink Rock") sand of the Sheffield quadrangle (Ingham, 1956, Plate 7). Records of the wells drilled below the Cherry Grove sand are published in Appendix C.

Exploration of Rocks Older than Devonian Age

A total of twelve deep wells (Middle Devonian or older) have been drilled in the quadrangle. Their records are published in Table 1.

The Marsh-Childs No. 1 is the deepest well in the quadrangle. It was drilled to a total depth of 8112 feet, had a show of gas in the Gatesburg (Upper Cambrian) and a show of gas in the Medina (Lower Silurian). After these two shows were tested the well was abandoned. The Charles Erickson No. 1 had a show gas in the Lockport (Middle Silurian) and a show of gas in the Medina. This well was also abandoned. Eight other wells tested the Oriskany. Four of them had shows of gas in the Oriskany but were abandoned. One was abandoned with a show of oil in the Oriskany. The other three were dry in the Oriskany. The Starbrick No. 1 well probably never reached the Oriskany and the Lot 515 No. 2 well had a show of oil in the Onondaga and was plugged and abandoned without testing the Oriskany.

GEOLOGIC STRUCTURE

Structurally, the Warren quadrangle lies in the northern part of the Appalachian Plateaus province which is west and north of the closely folded and faulted Valley and Ridge province. Along the eastern border of the Appalachian Plateaus province are a series of rather prominent northeast-trending anticlinal and synclinal folds. In the northwestern part of the province the folds have so diminished in magnitude that their detection and tracing are best accomplished by determining elevations on selected "key" rock layers at many points. The dominant structural features in this part of the Appalachian Plateaus province is a general southward regional dip. No faulting either in the surface or the subsurface has been observed in the quadrangle.

SUBSURFACE STRUCTURE

The subsurface structure, contoured on the base of the "Pink Rock," is shown on Plate 2. The "Pink Rock" is usually not recorded on the records of the wells drilled prior to 1950. Consequently data on the base of the "Pink Rock" are scarce. Most of the information came from wells drilled within the last five years.

The amount of dip of the subsurface units averages 35 feet per mile a little to the west of south. Just north of Warren borough the dip is about twice the average; in the Verbeck Island area west of Warren borough the rocks are level over a considerable area.

The most prominent features on the subsurface structure map are (1) the broad arch in Kinzua and Mead Townships, (2) the syncline extending through Pleasant, Mead, and Glade Townships, and (3) an apparent high south of Russell in Pinegrove Township.

The broad arch in Kinzua and Mead Townships is the northern extension of the structural feature mapped by Ingham (1956). Butts (1910) showed this feature but included also the Kinzua-Emporium anticline, in Kinzua Township, as the highest part in the arch. Plate 2 shows this arch continuing into the Sheffield quadrangle along the trend of the Clarendon oil field.

The syncline extending through Pleasant, Mead, and Glade Townships was partly shown by Butts (1910). Plate 2 shows the syncline ex-

Table 1. *Summarized records of deep*

Grid Location	C-3	N-5
Map Number	12	1
Name of Well	**Marsh-Childs No. 1**	**Chas. Erickson No. 1**
Operator	Transamerican Pet. Co.	C. E. Updegraff et al.
Township	Farmington	Elk
Date Completed	6/15/64	9/5/38
Elevation		1926
Tully	3380–3405	3760–
Hamilton		
Onondaga	3625–3740	4104–4197
Oriskany	3740–3755	4197–4199
Helderberg	3755–3820	4199–4257
Bass Island		4257–4287
Salina	3820–4420	4287–4982
Guelph-Lockport	4420–4660	4982–5246
Clinton	4660–4800	5246–5408
Grimsby	4800–	5408–
Whirlpool	4950–4960	–5545
Queenston	4960–	5545–
Trenton	7006–	
Gatesburg	7838–	
Total depth	8112	5630
Deepest Fm. reached	Gatesburg	Queenston
Remarks	SSG 8000–40 W/SW Perf. 7842-67 acidized PB 4970 SSG 4930 Perf. 4914 fraced, no results P & A	Salt 4600–4615 4620–4630 SG 5145–5148 SW 5148–5150 SG 5431–5433 P & A

Grid Location	B-14	N-13
Map Number	6	7
Name of Well	**Dunham Oil Co. No. 1**	**S.P.O. Co. G.T. Lot No. 74**
Operator	Kane Industrial Gas	L. B. French et al.
Township	Watson	Kinzua
Date Completed	1937	2/14/53
Elevation	1686	1882
Tully	4092?–4125	4325–4355
Onondaga	4284–4364	4585–4641
Oriskany	4364–4376	4641–4655
Helderberg	4376–	4655–
Total Depth	4444	4668
Deepest Fm. reached	Helderberg	Helderberg
Remarks	Onon. & Oris. fraced. AF 60 MCFG, 4 day R.P. of 1350 psi and 1 BOPD	Dry P & A

wells drilled in the Warren quadrangle

O-12	O-13	O-13	D-13
2	3	4	5
Lessor & Launer Lot 49 No. 1	**Lessor & Launer Lot 60 No. 1**	**M. H. Henhart**	**Anne Marck**
Potter Development Co.	H. C. Drilling Co.	G. L. Cabot	Belmont Quad. Dr. Co.
Kinzua	Kinzua	Kinzua	Pleasant
3/8/37	8/23/36	11/20/36	12/4/37
1994	1994	1912	1642
		4338–	4005–4054
4396–4676	4366–4620		
4676–4711	4620–4679	4599–4660	4218–4294
4711–4738	4679–	4660–	4294–4311
4738–4778			4311–
4778–4825			
4825–			
4928 Salina gas pocket at 4605 shot 4712–4715 100 MCFGPD 3 BPDSW P & A	4689 Oriskany Oris. fraced 620 MCF BF 1700 MCF AF SW drowned out gas AF, P & A	4662 Oriskany 7 MCF at 4661 SW rose 1300 feet in 24 hours P & A	4372 Helderberg SO 4295 1 BPDSW P & A

C-10	N-7	O-8	B-14
8	9	10	11
Starbrick No. 1	**Fenner Lindbloom**	**Warrant 5555 No. 1**	**Lot 515 No. 2**
?	J. T. Mallory et al.	S.P.O. Co. & J. T. Mallory et al.	Hill & Smith
Conewango	Glade	Glade	Watson
Pre-1910	6/10/59	3/25/60	9/2/60
1185	2029	1969	1908
3398–3430	4124–4164	4150–4191	
	4412–4483	4436–4505	4504–
	4483–4491	4508–4520	
	4491–	4520–	
3670 Hamilton? Dry P & A	4511 Helderberg Dry P & A	4528 Helderberg Dry P & A	4542 Onondaga SO 4542 P & A

tending from the southwest to the northeast across the quadrangle. The syncline is the northern extension of the one mapped by Ingham (1956) in Watson Township.

The structural high south of Russell in Pinegrove Township is based on sparse data. The few elevations shown on Plate 2 for the base of the "Pink Rock" in the northern part of the quadrangle indicate a high south of Russell and then a very small degree of dip north to the State line. A personal communication from an operator who has seismographed the area supports the interpretation of a structural high. John F. Carll (1883 p. 216) states that the surface beds indicate a high near North Warren.

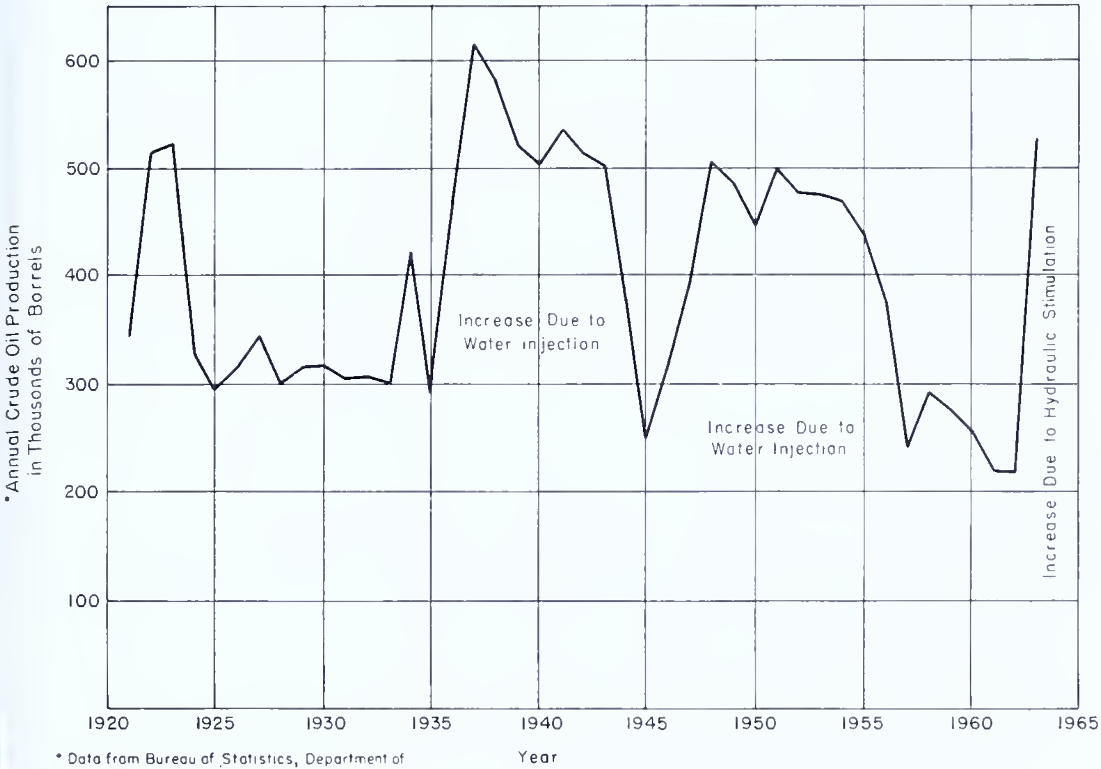
HISTORY OF OIL PRODUCTION

About 1865 an experimental well was drilled within the Warren borough limits but it failed probably on account of the crude manner in which such ventures were managed in those times. The history of this well has been forgotten. Therefore when David Beatty drilled Beatty No. 1 in Glade Township on the east side of Conewango Creek, an area which is now within the Warren borough limits, the area was virtually untested. The Beatty well (Appendix-C) was completed in March 1875 at a total depth of 632 feet after finding the top of the Glade sand at 615 feet and the oil pay from 620 to 629 feet. The well produced about 5 barrels of oil per day (BOPD). This well started the drilling activity in the Warren fields which continued at a rapid rate until 1895 except for the period 1877 to 1881.

At first the principal development was on the west side of Conewango Creek at North Warren where some wells had initial productions as high as 400 BOPD from the Glade sand. The production speedily declined and the territory was found to be limited in extent, treacherous and uncertain as to yield. Consequently many of the producers went to the Bradford fields. Very little development took place from 1877 until 1881 when again large producing wells were found on the western side of Conewango Creek near the northern boundary of Warren borough and drilling increased rapidly. Initial productions from these wells were up to 1000 BOPD.

The first well drilled southeast of the Allegheny River in the Clarendon Field was the Tolles well on January 13, 1878 at Bugsbee Mills, Warrant No. 55, near Stoneham. The initial production from the Clarendon sand was 20 BOPD. The Clarendon sand wells seldom had initial productions of more than 25 BOPD.

Drilling in the Warren area from 1881 to 1895 continued at a rapid rate. Since 1895 drilling has been sporadic except for the water flood projects during the past 20 years. In May of 1962 a Glade sand well responded very well to fracturing. This led operators in the area to try the fracturing method of completion which has proved very successful in most cases. Well stimulation by fracturing started a new wave of development drilling which, at the time of this writing, is presently active. The annual amount of crude oil produced in Warren Co. from 1921 to 1963, inclusive, is shown on Figure 2.



* Data from Bureau of Statistics, Department of Internal Affairs, Harrisburg, Pennsylvania

FIGURE 2. Warren County crude oil production curve 1929 to 1963 inclusive

OPERATING METHODS

Drilling Methods

The portable spudding machine with wire line is generally used in the quadrangle. A 10-inch hole is spudded to bedrock and a wooden conductor or, if the walls of the hole will not stand, 8-inch drive pipe is used. About 20 to 150 feet of drive pipes are used depending on the location of the well. As much as 250 feet of drive pipe might be needed in a few areas where the glacial cover is that thick. An 8-inch hole is drilled to the casing point, a point below which fresh water is no longer encountered (varying from 180 to 600 feet below the surface), and 6¼-inch casing is installed. A 6¼-inch hole is then drilled to total depth

Table 2. Range of hydraulic fracture treatment data [1]

Area	Fracture medium	No. of wells	Formation breakdown pressure, psi	Injection pressure, psi	Liquid treating volume, gallons	Liquid injection rate, bbl. per minute	Propping agent (sand), pounds	
							20–40 mesh	10–20 mesh
				Glade sand				
Warren	Water	11	1,600–5,000 [2](3,585)	1,350–2,450 (1,750)	7,600–14,300 (11,000)	13.5–24.5 (20.0)	7,500–15,000 (11,000)	2,500–10,000 (7,500)
Sugar Grove	Water	10	2,200–5,300 (3,820)	1,150–2,900 (1,706)	11,500–21,000 (15,900)	12.5–38.0 (28.0)	6,000–15,000 (10,600)	6,500–18,000 (13,000)
Morrison Run	Water	3	3,400–4,800 (4,400)	1,800–2,450 (2,100)	6,750–17,970 (11,390)	17.5–26.0 (20.5)	4,000–29,000 (12,600)	4,000–8,000 (6,000)
Morrison Run	Oil	5	2,050–4,200 (3,600)	2,100–3,500 (2,450)	8,200–12,250 (8,500)	9.0–18.0 (14.0)	4,000–10,000 (7,800)	1,000–5,000 (3,800)
				Clarendon sand				
Morrison Run	Oil-water	[3] 3	3,100–5,050 (4,000)	1,650–3,800 (2,600)	5,700–17,150 (10,200)	9.5–25.0 (18.0)	2,900–6,000 (4,200)	1,500–7,000 (3,500)
Warren	Water	7	3,000–5,000 (3,900)	1,750–2,300 (2,000)	4,800–15,800 (8,250)	16.0–21.0 (19.0)	3,000–29,000 (12,400)	1,000–12,500 (5,000)

[1] Reprinted from Rough and Eckard (1963).

[2] Average data in parentheses.

[3] One well treated with oil, two wells with water.

which generally includes a 10- to 20-foot pocket below the bottom of the sand. Sometimes the sand is cored. Coring is generally done with the cable tools using a "Baker" core barrel but a continuous core can be taken with a rotary rig and diamond tools.

Producing Methods

The wells are completed with 2-inch tubing, rods, plunger-type pump, and working barrel with a mud anchor. The pumping jack is generally homemade and of the Oklahoma type. The wells are usually pumped by central power but in the last few years the newer wells are being pumped with individual electric jacks. Some of the wells are not tubed and therefore are bailed.

Secondary recovery by air and gas drive has been used on a few leases. Water flooding has been used extensively in the Clarendon Field and will be discussed under that field heading.

Until 1962, wells in the area have always been shot with nitroglycerine. An average shot was 3 quarts per foot and ranged from 1 to 5 quarts per foot. In April 1962, a well on the Oakland Cemetery Tract was fractured in the Glade sand by the operator, L. Geer, with excellent results. The well started off with an initial production of 60 BOPD. By the end of September the well had paid for itself and was producing about 4 BOPD. The successful fracturing of this well caused other operators to use this method of completion not only in the Glade sand but also in the Clarendon sand. A Clarendon sand well on Lot 459 responded very well to fracturing, starting off at a rate of 50 BOPD and 38,000 cubic feet of gas per day (38 MCFGPD). Some of the operators used crude oil in the early fracturing treatments but most of the wells are now fractured with water. Table 3 lists the fracturing data from 29 wells in the Warren quadrangle and 10 wells in the Youngsville quadrangle. With the introduction of notching the breakdown pressure has been substantially reduced. Notching and multiple staging has increased the amount of oil produced to such an extent that it is economical to use these techniques in many cases. Prior to multiple staging the fracture was made in an open hole. Development costs including fracturing vary from $7,500 to $11,000.

Shot wells have initial productions averaging 10 to 20 BOPD while fractured wells have initial productions averaging 40 BOPD with a maximum of 140 BOPD. Rough (1963) stated that from the 39 fractured Glade and Clarendon sand wells studied in the Warren and Youngsville quadrangles the data indicated that "average cumulative oil production during the first 100 days will be 8.5 times greater than the production normally obtained from wells shot with liquid nitroglycerin.

Table 3. *Records of wells drilled in the Warren 7½ Quadrangle during 1962* *

* Well records from reports of Petroleum Information Corporation

Grid Location	G-11	E-13			
Well Name & No.	Oakland Cem. Tr. #6	Lot 488 #013	#013 Cont'd.	#013 Cont'd.	#103 Cont'd.
Operator	L. Geer	D. W. Franchot			
Township	Pleasant	Pleasant			
Elevation	1220	1594 Gr			
Casing		6⅝" 392'			
Sand	Glade	Glade	Clarendon	Clarendon	Clarendon
Top-Bott. ft.	740–800	1142–1205	1237–1267		
FRACTURING INFORMATION		1st stage	2nd state	Refractured	Refractured
Fracturing Interval		1151–1205	1238–1275	1249–1263	1249–1263
MCA gals.		500		2,000	
Water	Sand fractured	405	405	36 oil	179 oil
Sand 20/40 lbs.	Glade sand	30,000	30,000		4,000
Sand 10/20 lbs.		6,000	7,000		1,400
Breakdown Press. psi		3,800	4,700	5,500	
Treating Press. psi		5,250	2,500	4,700	4,400
Injection rate bbls/min.		5–22	15–30		10
Oil (IP-AF) bbls.	60/day				8/day
Gas (IP-AF) Mcf					
Total Depth ft.	801				1390
Completed	4/21/62				9/5/62
Remarks					Cherry Grove Sand 1356–acidized w/1000 gals.

Grid Location	D-12	G-11		G-12	
Well Name & No.	J. Pratt #1	Phillips #34	#34 Cont'd.	Lot 459 #20	#20 Cont'd.
Operator	J. Pratt	P. Phillips		Gary Mead	
Township	Pleasant	Pleasant		Mead	
Elevation	1300 Gr	1500 Gr		1600 Gr	
Casing	6½" 420'	6¼" 303'		6¼" 325'	
Sand	Glade	Glade	Clarendon	Glade	Clarendon
Top-Bott. ft.	860–975	996–1031	1102–1112	1125–1153	1217–1244
FRACTURING INFORMATION					
Fracturing Interval	891–907	996–1031	1102–1112		1222–1239

MCA gals.					
Water		357	75		280
Sand 20/40 lbs.		}20,000	}500		}15,000
Sand 10/20 lbs.					
Breakdown Press. psi	3,200	2,800	6,200		3,500
Treating Press. psi	1,600	1,800			2.500
Injection rate bbls/min.		20–22			18
Oil (IP-AF) bbls.	5/day	50/day	No results		50/day
Gas (IP-AF) Mcf		75/day			38/day
Total Depth ft.	916		1140		1253
Completed	7/24/62		7/31/62		7/21/62
Remarks					

Grid Location	D-13	E-13	D-12	H-11	
Well Name & No.	Lot 486 #024	Lot 473 #5	De Forest #1	F. H. Trax "2" Well #18	#18 Cont'd.
Operator	D. W. Franchot	Ken Sherry	Taylor Oil	C. Starr	
Township	Pleasant	Pleasant	Pleasant	Mead	
Elevation	1866 Gr.	1680	1380 Gr	1450	
Casing	6½" 538′	8¼" 32′		6¼" 260′	
Sand	Glade	Glade	Glade	Glade	
Top-Bott. ft.	1420–1450	1238–1397	922–982	940–1005	
FRACTURING INFORMATION		6¼" 1280′			
Fracturing Interval	1439–1450	1280–1290	947–75	Upper Gl. 940–968	Lower Gl. 985–1005
MCA gals.	100 lb. Moth B.				
Water	190 oil	300	333	212	200
Sand 20/40 lbs.	8,000		}15,000	}10,000	}9,000
Sand 10/20 lbs.	4,000				
Breakdown Press. psi	4,200	4,200	2,550	5,000	3,800
Treating Press. psi	2,500	2,300			1,800
Injection rate bbls/min.		17			20
Oil (IP-AF) bbls.	25/day	7/day			
Gas (IP-AF) Mcf			40/day		
Total Depth ft.	1462	1299	1090		
Completed	8/30/62	9/10/62	9/26/62		
Remarks					

Table 3. *Records of wells drilled in the Warren 7½ quadrangle during 1962* *—Continued

Grid Location		D-13	D-13	D-12	G-11
Well Name & No.	#18 Cont'd.	Lot 486 #023	Lot 486 #026	De Forest #2	Phillips #35
Operator		D. W. Franchot	D. W. Franchot	R. Taylor	P. Phillips
Township		Pleasant	Pleasant	Pleasant	Pleasant
Elevation		1878 Gr	1908 Gr	1380 Gr	1540 Gr
Casing		6¼″ 530′	6¼″ 520′	6¼″ 474′	6¼″ 350′
Sand	Clarendon	Glade	Glade	Glade	Glade
Top-Bott. ft.	1045–1065	1440–1464	1472–1484	920–	1066–1121
FRACTURING INFORMATION					
Fracturing Interval	1050–65	1444–64	1473–84	952–66	Upper Gl. 1067–1077
MCA gals.					
Water	200	440 oil	255 oil	325	300
Sand 20/40 lbs.	8,000	10,000	10,000	10,000	22,000
Sand 10/20 lbs.		5,000	10,000	10,000	
Breakdown Press. psi	1,500	3,000	3,000	3,200	5,000
Treating Press. psi		2,200	3,000		2,025
Injection rate bbls/min.		20		20.5	23
Oil (IP-AF) bbls.	40/day	70/day	5/day	40/day	
Gas (IP-AF) Mcf			250 psi BF		
Total Depth ft.	1090	1,475	1,508	983	
Completed	10/9/62	10/8/62	11/15/62		
Remarks					

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* Well records from reports of Petroleum Information Corporation

Grid Location			G-12	D-12	D-13
Well Name & No.	#35 Cont'd.	#35 Cont'd.	Lot #459	Jas. Prat #35	Lot 486 #12
Operator			Gary Mead #21	Carlson	D. W. Franchot
Township			Mead	Pleasant	Pleasant
Elevation			1520 DF	1390 Gr	1744 Gr
Casing			6¼" 314'	6¼" 430'	
Sand		Clarendon	Clarendon	Glade	Glade
Top-Bott. ft.		1176–1193	1166–1204	919–944	1293–1351
FRACTURING INFORMATION					
Fracturing Interval	Lower Gl. 1101–1123	1178–1190	1174–1200		1293–1351
MCA gals.					
Water	223	224	400	400	Sand-oil
Sand 20/40 lbs.	16,850	17,000	27,000	20,000	Fractured old hole
Sand 10/20 lbs.					
Breakdown Press. psi	3,400	3,100	3,200	3,700	
Treating Press. psi		1,700	2,000	1,800	
Injection rate bbls/min.	20	22	21.5	20	
Oil (IP-AF) bbls.		Total 140/day		40/day	50/day
Gas (IP-AF) Mcf		RP 300 psi			
Total Depth ft.		1,216	1,254	967	1,384
Completed		11/10/62		11/20/62	
Remarks					

"Hydraulically fractured new wells should produce an average of 5.5 barrels of oil a day 100 days after completion; and new wells shot with liquid nitroglycerin should produce an average of 1.8 barrels of oil a day 100 days after completion."

The oil from the Glade and Clarendon sands differs in character (see Hempel Analyses, Appendix B). The Glade oil is dark green, nearly opaque, and of 40° gravity, whereas, the Clarendon oil is amber colored, transparent, and of 47° gravity. Some of the oil wells yield enough gas to supply fuel for the gas engines used to pump the wells. Two wells drilled in 1962 supplied 38 MCFGPD and 75 MCFGPD along with the produced oil.

OIL AND GAS FIELDS AND POOLS

GLADE SAND

Warren Field

The Warren Field consists of the following pools: East Warren, North Warren, West Warren, South Warren, and Sill Run.

East Warren Pool

The Glade sand is the second most important producing sand in the Warren quadrangle. The discovery well, Beatty No. 1 described under history of oil production, is located in this pool. The sand was named from the township in which the well was drilled. The East Warren Pool is approximately 3 miles long and 1½ miles wide.

The Glade sand is a very fine- and medium- to locally coarse-grained, light-gray sandstone. It varies in thickness from 15 to 60 feet. The sand body in the pool averages 40 feet in thickness over most of the area and is found at depths ranging from 750 to 1100 feet.

The largest producers of Glade sand oil were drilled in this pool. Initial productions of 200 to 300 BOPD were common with the highest being 1000 BOPD. The oil was generally found about 5 feet below the top of the sand which often had a thin calcareous cap rock. The spacing of wells in the pool is irregular around the edge but where the property has been completely developed the wells are commonly 300 to 500 feet apart. The gas pressure in the pool is greatly depleted. A well completed in 1965 had a rock pressure of 28 pounds per square inch (psi). Two new wells were fractured and one started off at 20 BOPD in 1956 and the other at 40 BOPD in 1963.

Four wells on the John M. Hunter farm (Map Index H-9) produce mostly from the Glade sand. Well number 3 was shot in Warren First sand as well as in the Glade and Clarendon sands. A little very light oil from this well was produced from the Warren First sand. Another outlying pool is the 6-well pool on the Theo Thelin (Map Index I-10) farm which produced from the Glade sand.

The Clarendon sand is productive under a section of the East Warren Pool. Production from this area of Clarendon sand will be discussed under the Clarendon sand heading. Several scattered wells in other sections of this pool produced a small amount of oil from the Clarendon. The top of the Clarendon sand in this area is found about 117 feet below the top of the Glade sand. The Glade sand was generally shot with 80 to 140 quarts of nitroglycerin and the Clarendon, where productive, with 40 quarts. During the recent drilling 6 new wells were completed in the pool—3 were fractured and 3 were shot.

North Warren Pool

After the discovery of oil by the Beatty well most of the development was to the north in the North Warren Pool. The pool is approximately 2 miles long and 1½ mile wide. Initial production from the Glade sand was as high as 400 BOPD. The area was very active from 1875 to 1877. Although many of the wells produced considerable quantities of oil, production was spotty; a number of operators lost heavily and most moved to the Bradford Field. Since then the drilling has been very sporadic.

The Glade sand is a very fine- to medium-grained and locally coarse-grained, light-gray sandstone. It is found at a depth of 500 to 700 feet and varies from about 14 to 60 feet in thickness. The wells are not drilled on a pattern and the spacing varies from 100 to 800 feet with considerable untested acreage between some wells. In the early days the wells were shot with 80 to 100 quarts of nitroglycerin. Today some of the hydraulically fractured wells have initial productions of 50 to 70 BOPD but fall off rapidly. The top of the Clarendon sand is found about 110 feet below the top of the Glade sand. A sand called the North Warren which lies at the stratigraphic position of the Cherry Grove sand produced some oil and gas in several wells in the North Warren Pool. The top of the Cherry Grove is found approximately 100 feet below the top of the Clarendon.

West Warren Pool

Exploration in the late 1870's shifted from the North Warren Pool to the West Warren Pool. The sand in this pool is a fine- to medium-grained and locally coarse-grained, light-gray sandstone. The thickness varies from 20 to 60 feet. A well in the center of the pool was cored. The Glade sand showed a total oil content of 6102 barrels per acre or 321 barrels per acre foot. The porosity averages about 16 percent. The permeability ranges from impermeable at 80 psi to 73 milidarcies. The most permeable and porous part of the sand was in the top of the pay. The upper 19 feet of the unit are sandstone while the bottom 20 feet are siltstone. In some wells the gas pay lies 5 feet from the top of the sand and the oil pay occurs from 10 to 50 feet below the top depending on the total sand thickness as logged by the driller. Some wells drilled in 1964 in the pool had a rock pressure after fracturing of 50 to 66 psi. The initial productions of the early wells were not as high as the East Warren and North Warren pools. The depth to the Glade varies from 650 to 1180 feet. The interval from the top of the Glade to the top of the Clarendon is 108 feet. Only a few wells in this pool have produced from the Clarendon.

The wells at Venturetown (Map Index F-9) produce from the Glade and Clarendon sands.

In the bend of the Allegheny River (Map Index F-10) on the Biddle and Newbold farms the Glade sand is 30 feet thick, very fine grained and hard. The wells did not produce enough oil and were abandoned. This type of sand might produce in commercial quantities if fractured.

South Warren Pool

The South Warren Pool is composed of several small producing areas. The largest area is along the river south of the East Warren Pool. The other small producing areas are located in map index square I-10, at St. Joseph Cemetery, at Oakland Cemetery, and on the I. Yeager and H. Peterson farms (Map Index F-11).

The Glade sand is a very fine- to medium-grained, light-gray sandstone. It ranges from 15 to 60 feet in thickness at depths of 700 to 1150 feet. The sand is typically hard and tight at the top with the first pay occurring from 10 to 15 feet below the top and extending for 18 feet. Below this is a 5-foot shale break, and a second pay of 13 feet. In the 1890's the initial productions after shot were about 20 BOPD but in 1964 the initial productions were 5 to 10 BOPD for wells shot with 140 quarts of nitroglycerin and 20 to 50 BOPD for those wells hydraulically stimulated. The first successful hydraulic fracture treatment in the Glade sand oil fields of Warren County was in the Oakland Cemetery Lot well no. 6 operated by L. Geer. The well was fractured in an open hole on April 21, 1962. Some of the fractures penetrated the Glade sand in an old hole 215 feet distant. After flowing 15 barrels of water used in the fracture treatment, the old well produced 10 to 15 barrels of oil a day for 2 weeks and then settled to its former rate of one-eighth barrel a day. Cemetery lot well no. 6 produced 50 BOPD initially and after 220 days had produced 1,619 barrels. The daily and cumulative production figures from the fracturing date April 21, 1962, to the middle of February 1965 are shown on Figure 3. Since the completion of Oakland Cemetery Lot well no. 6, approximately a dozen wells have been drilled in the South Warren Pool. One-half of these have been shot and the rest hydraulically fractured. The well spacing in this pool varies from 100 to 600 feet.

At least two wells have been cored in the pool. The core analyses show the permeability range to be .01 to 84.5 millidarcies, the porosity from 6.18 to 16.75 percent, the weighted average saturation 42 percent, the oil content from 202 to 402 barrels per acre foot, and the total oil content at 11,408 barrels per acre.

A repressuring project was operated on one of the properties for a short period with the gas affecting two wells. The project was later discontinued.

Very little salt water, if any, accompanies the produced oil from the Glade sand in the Warren quadrangle. At the southern end of the small productive area on the I. Yeager farm, Map Index F-11, two gas intake wells were cored and the lease repressured.

Still Run Pool

Included in this pool are some small productive areas to the north of the main productive area on the Pratt farm (Map Index D-12) and the area in Lot 456. The Dingley well, a small producer, was the discovery well drilled in 1874. The Glade sand in this area is a very fine- to fine-grained, gray silty sandstone. It averages 30 feet in thickness and is found at a depth ranging from 800 to 950 feet. From 1 to 3 shale breaks occur within the sand section. The thickest break is about 5 feet and lies in the middle of the unit. A core report gives the maximum porosity as 15.44 percent, the minimum as 4.15 percent, and the average as 10.37 percent. The average oil saturation for the core is 20.3 percent with a maximum of 32.1 percent and a minimum of 8.4 percent, the total oil content being 5,348 barrels of crude oil per acre. The average permeability is .37 millidarcies with a maximum of 4.73 millidarcies. Secondary recovery has never been tried in the Still Run Pool, although several development wells have been drilled in the last few years. The general completion practice is to fracture the Glade sand. Initial production after fracturing ranges from 5 to 10 BOPD. The Clarendon sand is generally very shaly in this pool.

The small producing area in Lot 456 is productive from the Glade and Clarendon. The Glade is found at a depth of about 1350 feet with a thicknees of 25 to 30 feet and the Clarendon at 1470 feet with a thickness of 20 feet. The sands were shot with 20 to 60 quarts of nitroglycerin. New

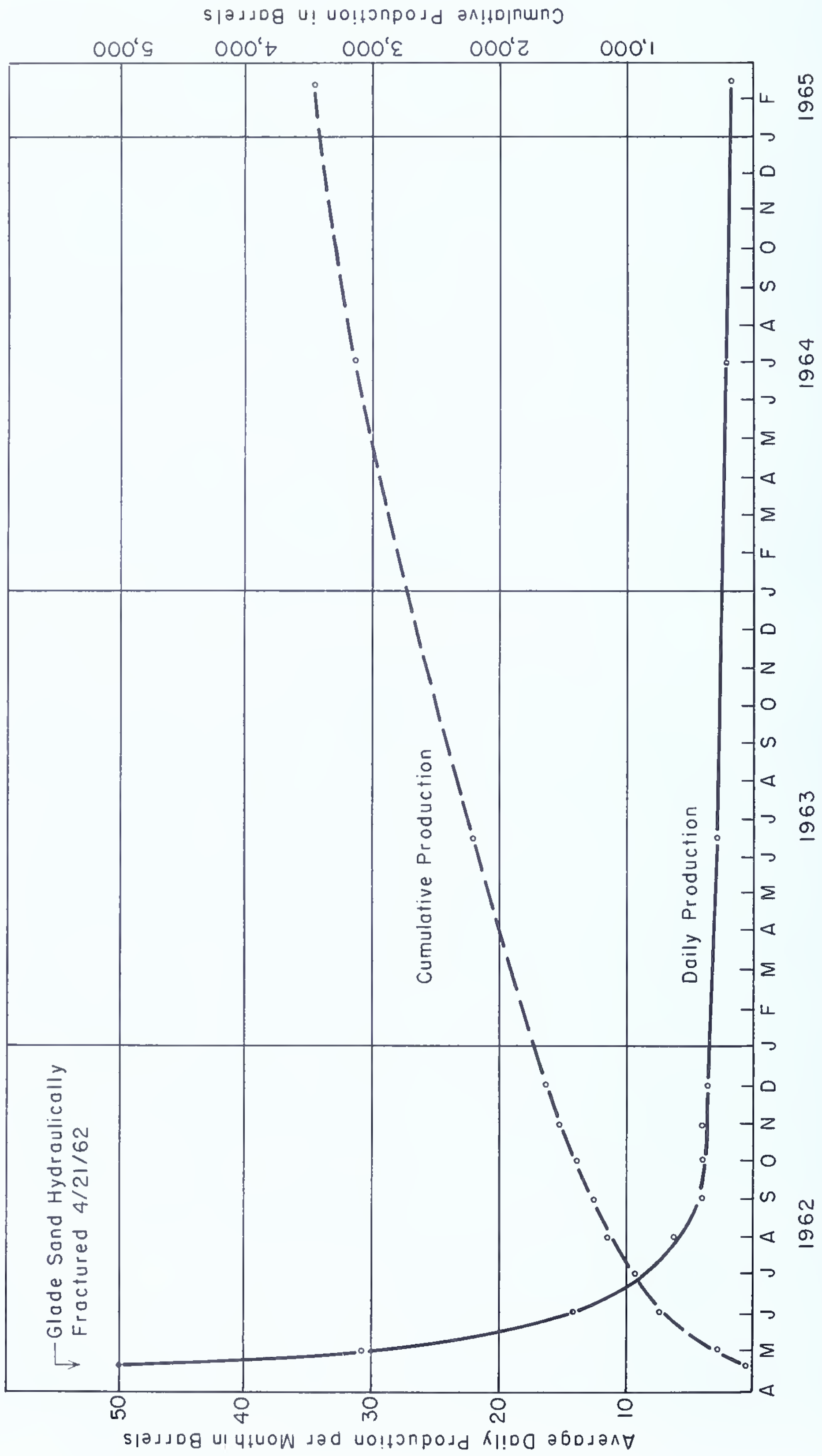


FIGURE 3. Crude oil production curve of Oakland Cemetery Lot well #6

wells started off at 7 BOPD but rapidly decreased to one-half barrel a day where there was no secondary-recovery method applied. In 1935 a gas repressuring project with a "five-spot" pattern was started on the property with seven producing wells and two gas input wells. The Glade and Clarendon sands were both repressured. Each input well took 10,000 cubic feet of gas a day at a pressure of 400 psi. Some beneficial effects occurred, but the project evidently was not successful for the rest of the planned development program was never carried out. The gas from the two sands when compressed produced about 4 gallons of gasoline per 1000 CF.

Glade Field

The Glade Field is productive of oil from three different sands—the Glade, Clarendon, and Gartland. Each will be discussed under the proper sand heading.

The Glade sand in this field covers a productive area 2 miles long and 1 mile wile. The sand is generally a very fine- to fine-grained, gray sandstone with the following properties: permeability .01 to 27.8 millidarcies (average .40), porosity 9.1—15.1 percent (average 11.9 percent), and an oil content of 277 barrels per acre foot or 10,243 barrels per acre. The well spacing varies from 100 to 700 feet. The Glade sand is found from 900 to 1250 feet in depth and ranges from 25 to 50 feet in thickness. In the western part of the field the sand has a 10-foot shale break in the middle. When the sand is shot, 60 to 100 quarts of nitroglycerin are used. In recent years several wells have been fractured. The initial production after fracturing varies from 40 to 140 BOPD.

Morrison Run Field

In addition to the main producing trend along Morrison Run, three small areas just to the south of the run will be described.

The Glade sand is a very fine- to fine-grained, light-gray to greenish-gray sandstone with abundant interbedded greenish-gray siltstone. The wells are spaced 200 to 600 feet apart. The Glade sand ranges from 1000 to 1400 feet in depth and 24 to 60 feet in thickness. Well 013 on Lot 488 is included in the cross-sections on Plates 6 and 7. The thickness of the sand in well 013 can be compared with other wells in these two cross-sections. In some parts of the field gas is found about 10 feet below the top of the sand in a 10- to 20-foot unit of sand separated from the 15-foot oil sand below by a 10- to 15-foot shale break. The Glade sand was cored in well 013 Lot 488 by D. W. Franchot and Company Inc. A summary of the findings is recorded below.

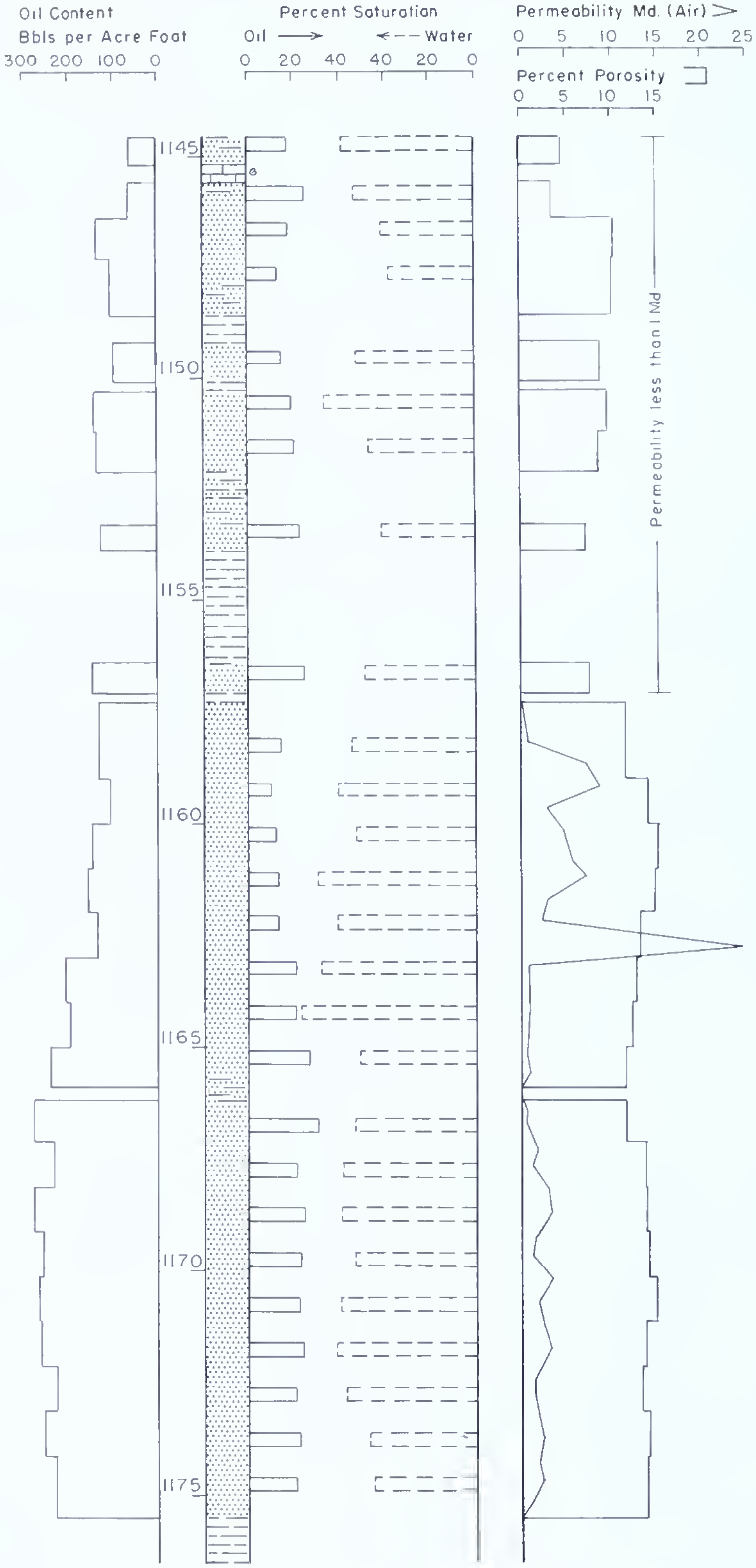


FIGURE 4. Core analysis profile (Glade Sand) of well #013 Lot 488, Morrison Run Field

Section cored in feet	*Aver. oil saturation %*	*Aver. oil saturation bbls/acre ft.*	*Aver. % Porosity*	*Average Permeability Millidarcies*
1144.6-1157.1	18.1	113	8.08	.21
1157.3-1163.0	12.7	132	13.37	5.90
1163.0-1175.5	23.2	239	13.32	1.64

A detailed report of this core is shown on Figure 4.

Seven wells have been drilled in the field in the last 3 years. All seven have been fractured in the Glade sand and 3 have been fractured in the Clarendon sand. Those fractured only in the Glade sand had initial productions of 7 to 70 BOPD. The rock pressures ranged from 200 to 250 psi before fracturing. A graph, Figure 5, shows the daily and cumulative production of a well in the Morrison Run Field after being fractured in both the Glade and Clarendon sands. Wells shot in the Glade sand have initial productions up to 30 BOPD and decline to 1 BOPD in a week. The average daily oil production per well is one-half barrel from a shot well after reaching settled production.

An unintentional water flood caused some increase in oil production from nearby wells in a section of the field.

The small productive area in Lot 507 operated by J. B. Haddon is producing from a 40-foot thickness of Glade sand which is divided into two units by a 5- to 10-foot shale section about 15 feet below the top of the sand. The sand was shot with 40 to 80 quarts of nitroglycerin. In 1944 the total daily production was 1 BOPD.

The lease on the F. Schrick Estate Lot 504 produces gas and oil from a 40-foot section of Glade sand. The wells produced small amounts of oil but considerable amounts of gas.

The small producing area on Lots 491 and 502 produces gas and oil from the Glade sand at an average depth of 1250 feet and oil from the Clarendon sand at 1390 feet. Both sands are approximately 30 feet thick.

CLARENDON STRAY SAND

Clarendon Field

Big Bend Pool

The Big Bend Pool and several other small areas in the Clarendon Field produce gas or oil from the Clarendon Stray sand. This sand is a very fine- to fine-grained, medium-gray silty sandstone with some interbedded shale. In the Big Bend Pool area the top of the Clarendon Stray sand is about 80 feet below the top of the Glade sand. The Clarendon Stray sand and Clarendon sand are one unit in some wells. The Clarendon Stray sand is approximately 20 feet thick. It produces mostly gas in the

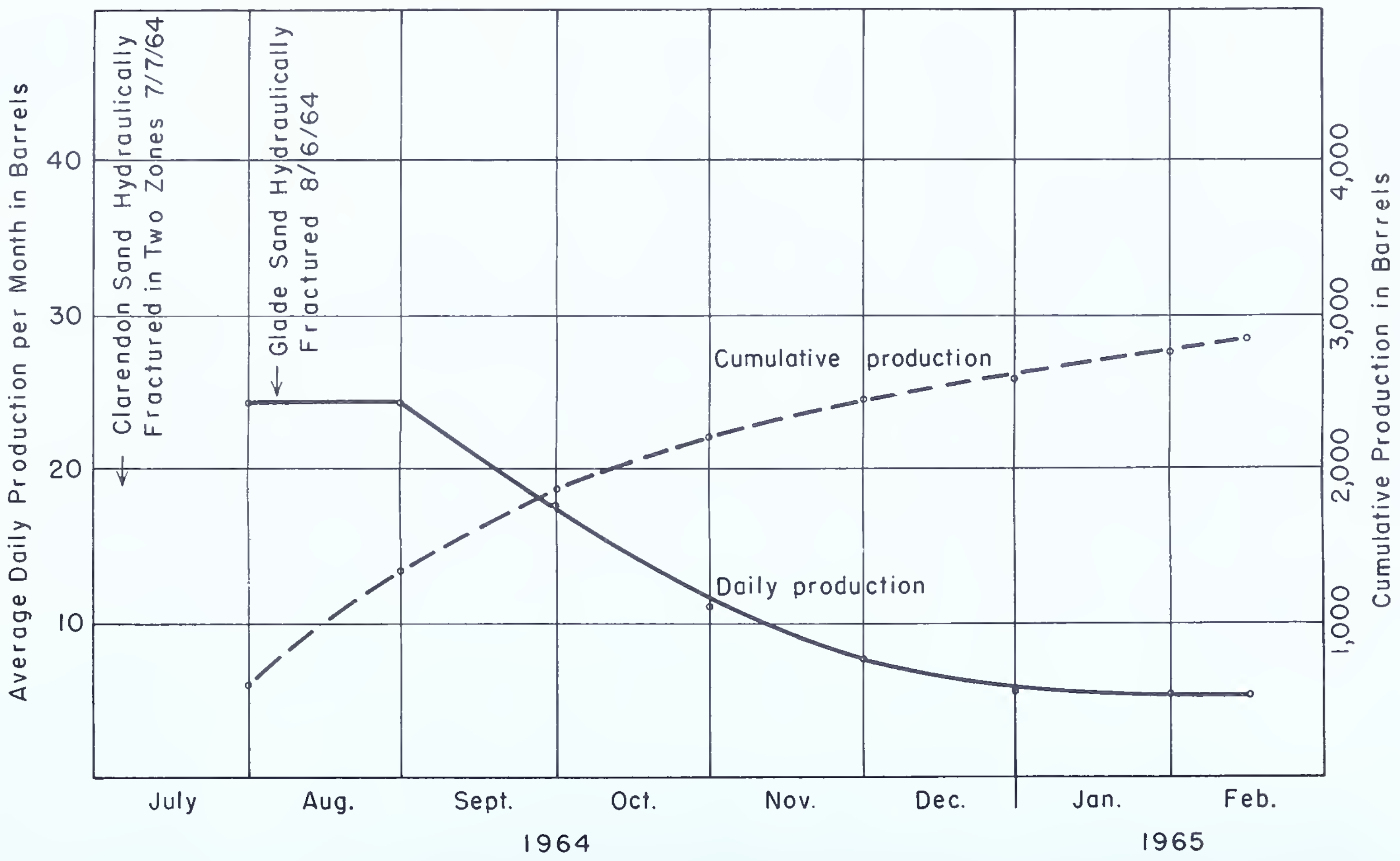


FIGURE 5. Crude oil production curve of a well in the Morrison Run Field

area but some wells produce a little oil. The Clarendon sand lying below the Clarendon Stray sand is a medium-grained sand. The depth to the Clarendon Stray sand averages 1100 feet.

On the Morck and Deacon farms (Map Index J-11) the Clarendon Stray sand is 20 to 30 feet thick and produces oil. It is separated from the Clarendon sand below by a 4-foot shale unit. A recently completed well was fractured in the Clarendon Stray sand. Its initial production was 27 BOPD at a rock pressure of 140 psi.

CLARENDON SAND

Clarendon Field

Clarendon Pool

The Clarendon Pool is the largest oil pool in the quadrangle. It is 8 miles long and 4½ miles wide. Its trend is north and south. The oil production comes from the Clarendon sand which is a very fine- to fine-grained, light-gray sandstone containing some medium grains. The upper 4 to 5 feet of the unit is usually medium to very coarse grained and contains gas. The Clarendon Stray sand is often recorded as Clarendon sand by the drillers because it is hard to distinguish between them. The Clarendon Stray sand lies immediately above the Clarendon sand and is separated from it at times by but a few feet of shale (Plate 8, well 2) or by a foot of cap rock.

The Clarendon Pool was discovered by the Tolles No. 1 well near Stoneham in Lot 55 on January 13, 1878. The initial production was 20 BOPD. Initial productions from wells in the pool were never very large. The Clarendon sand ranges in thickness from 20 feet or less along the boundary of the pool to 40 feet or more in the center. It is found at a depth of 900 to 1500 feet. In the northern part of the pool the Clarendon Stray sand is often included in the thickness of the Clarendon sand. The true Clarendon sand is found from the area around Stoneham south to the southern boundary of the quadrangle.

Air and gas repressuring have been used in the pool. One project had 4 gas injection wells. Each well injected 10,000 cubic feet of gas per week at a pressure of 200 psi. After injecting gas for 3 years the producing wells affected by the injection were producing 1 BOPD. The project was abandoned at the end of the 3 years.

Many of the leases from Stoneham to the southern quadrangle line have undergone intensive water flooding. The original wells were drilled on a 10-acre spacing. When a new well produced only 2 BOPD the pool was not extended any farther in that direction. The Clarendon sand was shot with 75 to 175 quarts of nitroglycerin. Since hydraulic fracturing was introduced into the area in 1962, most of the new wells are being fractured. Initial productions after fracturing range up to 120 BOPD.

The average porosities, permeabilities, saturations, and oil contents for the Clarendon sand from the northern part of the pool to the southern line of the quadrangle are listed below.

Pool Location	*Average Porosity Percent*	*Average Permeabilities Millidarcies*	*Aver. Oil Saturation Percent*	*Aver. Oil Saturation Bbls/acre ft.*	*Oil content Bbls. per acre*
Northern End	11.1	1.01		184	10,200
Northern End	11.6	2.90		220	6,250
Middle	12.4	2.08	27.8	295	8,201
Middle	14	11.80	25.3	282	7,954
Middle	12.03	1.04	21.1	197	5,527
Southern End	10.8	21.50		278	7,370
Southern End	11	1.02		233	5,670

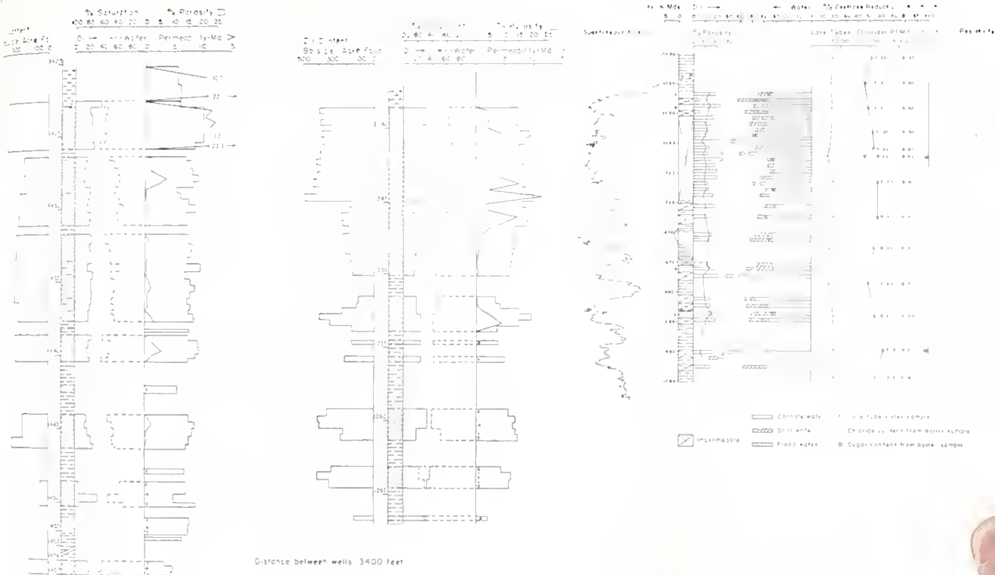
Figure 6 is a graphic profile of three core analyses of the Clarendon sand. Two of the wells are only 3400 feet apart. The right profile shows a detailed core analysis where dextrose was used in the drilling water. The total volume of water used in the hole was measured so the amount of connate, drill, and flood water could be determined. A close check on the dextrose added to the drill water and chlorides of the connate was kept at all times so the correct water determinations could be made.

Figure 7 is a production decline curve of a lease operating in the Clarendon Pool. A water flood was started on this lease in 1945. The wells were drilled on a spacing of 3.6 acres and all the wells were shot. The water injection wells each injected 10 barrels of water a day. In 1947 the plant pressure was 700 psi; in 1950, 800 psi; and in 1947, 800 to 1200 psi. In March 1961 there were 31 oil wells and 45 injection wells abandoned. At the end of 1962 the entire project was abandoned. The water flood had recovered 990 barrels per acre. Some water floods in the pool recover up to 2500 barrels per acre.

Glade Field

In the northern part of the Glade Field the Clarendon sand is productive over a small area. It ranges in thickness from 10 to 30 feet and is found at an average depth of 1000 feet. The Clarendon sand produces very little oil in this area.

On F. H. Trax "2" (Map Index H-11) the Clarendon sand is productive in a few wells. It is 20 to 40 feet thick and is found at depths ranging from 1100 to 1400 feet.



Distance between wells 3400 feet

* Permeability less than Md

FIGURE 6 Core analysis profiles (Clarendon Sand) of wells located in the central part of the Clarendon Field

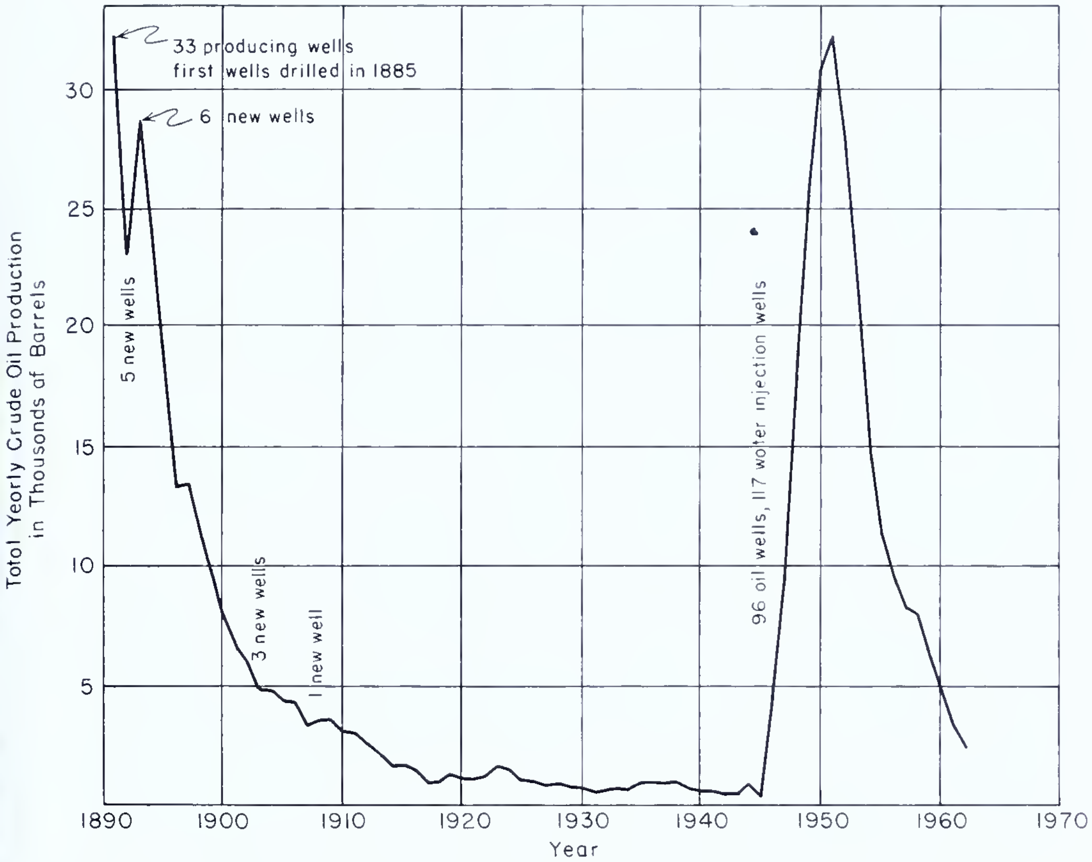


FIGURE 7. Crude oil production decline curve of a water flood lease in the Clarendon Field

Morrison Run Field

The northwestern part of the Morrison Run Field produces mostly from the Clarendon sand. It ranges from 15 to 30 feet in thickness and 1000 to 1500 feet in depth. About 2 to 5 feet below the top of the Clarendon sand occurs the 8- to 15-foot-thick pay section containing gas in the upper part. In recent years some operators have fractured the sand. Initial productions after fracturing have been as high as 50 BOPD.

Smith Corners Field

In 1919 the Scheckler No. 1 well was drilled west of what is now the Smith Corners Field. The well had 18 inches of oil-saturated Clarendon sand. The Guffy well was drilled in 1885 but was never pumped. In 1936 the Guffy well was opened up and pumped. During the same year some new wells were drilled in the vicinity of the Guffy well. As development progressed it was seen that the Clarendon sand increased in thickness and production to the east. On the G. T. Madigan farm the thickness of the sand was 10 feet and increased to 30 feet on the Hammermill Paper Co. property and to 45 feet on the Wendel McMillen "A" farm.

The drillers' records state that the Clarendon sand is a soft sand. It occurs about 115 feet below the top of the Glade sand and 345 feet below the top of the "Pink Rock." In the Smith Corners Field the Clarendon sand is found at an average depth of 1300 feet. The wells are shot with 25 to 80 quarts of nitroglycerin. The initial production in the western part of the field is about 1 BOPD, ranging up to 16 BOPD in the eastern end of the field. Four oil wells on the G. T. Madigan farm produced 2000 barrels of oil in 6 years and an additional 1000 barrels in the next 3 years. Many of the wells produce gas as well as oil. The best gas well was M. O. Knupp "A" No. 1 well with an initial production of 1,500 MCFGPD. Several wells had initial productions of 100 MCFGPD. The recorded rock pressures ranged from 40 to 92 psi.

Warren Field

The Clarendon sand is productive in scattered areas of the Warren Field. One area is in the southern part of the East Warren Pool. The Clarendon sand is 10 to 25 feet thick and is found at a depth ranging from 1000 to 1250 feet. The sand is shot with approximately 50 quarts of nitroglycerin.

GARTLAND SAND

Glade Field

Gartland Pool

The Gartland Pool was discovered in 1876 when the Schatzle No. 1 well was completed for an initial production of 1500 BOPD. The pool trends northeast-southwest and lies south of and parallel to Ott and Glade Runs. The pool is approximately 5 miles long and one-half mile wide. Oil and gas production is obtained from the Gartland sand which is coarse, white and pebbly. The sand varies from 10 to 30 feet in thickness with the pay sand averaging 10 feet thick. It is found at 50 to 60 feet below the top of the Clarendon sand and 800 to 1100 feet in depth. The Gartland sand is generally shot.

Gas repressuring has been used in this pool for several years. The average porosity is approximately 12 percent and the permeability ranges from 190 to 3,000 millidarcies with a high of 10,000 millidarcies. Due to the high permeabilities the pressure needed for gas drive is only 40 to 45 psi. Gas repressuring on one lease doubled the production in 4 months. Two years later the wells were each averaging 1 BOPD.

CHERRY GROVE SAND

Clarendon Field

Cherry Grove Pool

The Cherry Grove Pool of the Sheffield quadrangle extends its northern tip into Lots 556, 557, 560, and 561 in the southern part of the Warren quadrangle. The discovery well was the "Mystery" well drilled in 1882 and producing 2000 BOPD on June 13. The Cherry Grove sand is 10 to 15 feet thick and is found at a depth of 1200 to 1500 feet. The sand is generally a fine- to coarse-grained, white sand containing pebbles.

FUTURE EXPLORATION AND DEVELOPMENT

The introduction of hydraulic fracturing into the Warren area may make economical the drilling and production of the fine-grained, low permeability sands. The success that the operators have had so far with hydraulic stimulation indicates that it is economical in most cases. The Glade and Clarendon sands have the necessary physical properties within the present field and pool limits for successful fracturing treatment.

There is considerable acreage in the Warren quadrangle that has not been adequately tested. Very few wells have been drilled in the northern one-third of the quadrangle. Those that were drilled there have no records and were drilled so long ago that no one remembers much about them. In addition to drilling within the limits of the fields and pools, an effort should be made to extend the limits.

The Smith Corners Field should respond to fracturing. The limits of this field have never been established.

Between the Warren and Morrison Run Fields a thick Glade sand should be present. Also the Clarendon sand should be developed in small areas. Between Morrison Run and the Clarendon Fields is an area where the Glade and Clarendon sands might be productive. A favorable location for Glade sand production is the area south of the western end of the Morrison Run Field.

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APPENDIX A

Lithologic description of well cuttings from well 013, lot 488, Morrison Run Field

Well No. 013 Lot 488
D. W. Franchot
Pleasant Township, Warren County, Pa.
Warren 7½ min. Quadrangle: 14,850 feet south of 41°50′ and 350 feet west of 79°10′

Elevation: 1594 Ground
Total Depth: 1391 Feet

Description by W. R. Wagner

Thickness Feet	*Description of Strata*	*Depth in Feet*
	MISSISSIPPIAN SYSTEM, 45+ feet	
	Knapp Formation, 45+ feet	
6	Sandstone, 80%, fine- to coarse-grained, subangular, pebbly, weathered yellow, red, and orange by iron oxide. Siltstone, 20%, weathered grayish-orange to pale-yellowish-brown (10YR6-7/2),* in part argillaceous	0 – 6
19	Sandstone, pebbly, 85%, similar to above, but very fine- to fine-grained sand to coarse-grained silt, occasional medium-grained sand. Shale, 15%, grayish-orange (10YR6/2) to light-olive-gray (5Y5/2), weathered, micaceous and in part silty	6 – 25
10	Siltstone, 55%, grayish-orange to pale yellowish-brown (10YR6-7/2), in part very fine sandy and in part argillaceous. Sandstone, 45%, pebbly, medium- to coarse-grained, N8-N9, somewhat weathered by iron oxide staining	25 – 35

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* Color symbols used in this description are those found in the Rock-Color chart distributed by the Geological Society of America. Because most of the shales and sandstones are shades of gray, only the symbols for these colors, which are listed below, appear in the description. Where colors other than gray occur, the description contains both the symbol and the word meaning.

N9 – white
N8 – very light gray
N7 – light gray
N6 – med. light gray
N5 – med. gray
N4 – med. dark gray
N3 – dark gray
N2 – grayish black
N1 – black

Thickness Feet	*Description of Strata*	*Depth in Feet*
10	Sandstone, 70% pebbly, medium- to very coarse-grained, N9-N8, slightly weathered. Siltstone, 30%, very fine sandy, pale-yellowish-brown (10YR6/2) to light-olive-gray (5Y5/2), in part argillaceous	35 – 45
	DEVONIAN SYSTEM, 1346+ feet *Riceville Formation,* 82 feet	
15	Claystone and shale, 60%, medium-light-bluish-gray (5B6/1), micaceous, in large part silty and grading to argillaceous siltstone, containing trace of carbonaceous plant fragments. Sandstone, 40%, very fine-grained sand to coarse-grained silt, pebbly, weathered yellow, red and orange	45 – 60
26	Shale, N4-N6 and light-bluish-gray (5B7/1), in large part slightly to somewhat silty, micaceous. Some interbedded sandstone 60-73, coarse-grained to pebbles, N9-N8	60 – 86
7	Siltstone, 60%, argillaceous, medium-light-greenish-gray (5G7/1), friable. Shale, 30%, N5, similar to above. Sandstone, 10%, similar to above	86 – 93
34	Shale, 80%, N5-N6, in part silty, somewhat micaceous. Sandstone, 10%, very fine-grained, yellowish-brown and weathered from 93-116, medium-light-greenish-gray (5G7/0.5) and in part somewhat calcareous 116-127. Sand, 10%, coarse to pebble-size, broken	93 – 127
	Cattaraugus Formation, 334 feet	
13	Siltstone, 85%, medium-light-greenish-gray (5G7/0.5), in part somewhat argillaceous, in part micaceous and friable, few pieces calcareous, containing rare very fine-sand grain. Shale, 15%, N5-N6, in small part silty	127 – 140
21	Siltstone, coarse-grained silt to very fine-grained sand, medium-light-greenish-gray (5G7/0.5), in part N5-N6 from 155-61 and trace of pinkish-gray (5R6/1) 140-47, slightly micaceous, containing carbonaceous plant fragments, in large part argillaceous 155-61. Some interbedded shale 147-161, N5-N6	140 – 161
28	Sandstone, 90%, very fine-grained sand to coarse-grained silt, medium-light-greenish-gray (5G7/0.5) to N7, in part slightly argillaceous 161-69, very slightly calcareous 169-85. Shale, 10%, N5-N6, in part silty	161 – 89
3	Shale, 60%, N5 to medium-olive-gray (5Y5/1), in small part silty. Sandstone, 40%, similar to above but grading to sandy siltstone	189 – 192
5	Sandstone, 90%, very fine- to fine-grained, rare medium grain, N7-N8 and grayish- to pale-yellowish-green (10GY5-7/2). Shale, 10%, N5-N6, micaceous	192 – 197
2	Shale, grayish-red (5R4/2), in part silty and fine sandy	197 – 199

Thickness Feet	*Description of Strata*	*Depth in Feet*
16	Sandstone, 80%, very fine-grained sand to coarse silt, occasional coarse to very coarse sand. N6-N9 and subordinate light-greenish- to greenish-gray (5G8-6/1). Shale, 20%, N5, soft, slightly micaceous	199 – 215
10	Sandstone, 55%, similar to above. Shale, 45%, similar to above	215 – 225
6	Siltstone, 50%, N5-N6, in part containing a little very fine-grained sand, in part argillaceous, grading to silty shale. Siltstone, 40%, quartzose, coarse-grained silt to very fine-grained sand, occasional coarse sand, very slightly calcareous. Shale, 10%, N5, soft, clayey	225 – 231
15	Siltstone, 85%, greenish-gray (5G-GY6/1-0.5), slightly to somewhat argillaceous, 10% is somewhat calcareous. Shale, 15%, olive-gray (5Y5/0.5), soft	231 – 246
38	Sandstone, very fine-grained, coarse to very coarse grains occasional to common, N8-N7 and medium-light- to light-greenish-gray (5G8-7/0.5), 10% somewhat calcareous 271-81. Some interbedded shale 263-284, N4-N6, soft, in part slightly calcareous	246 – 284
11	Sand, 50%, very fine- to coarse-grained, N7-N8, unaggregated. Shale, 50%, N4-N5, soft	284 – 295
10	Sand, 30%, coarse- to very coarse-grained, unaggregated, N8. Sandstone, 65%, very fine-grained sand to coarse-grained silt, medium-light-greenish- to greenish-gray (5G7-6/0.5) to N7-N6. Shale, 5%, N5 to greenish-gray (5G5/0.5), soft	295 – 305
9	Siltstone, 80%, largely argillaceous, medium-light-greenish-gray (5G7/1) to N7-N6, grading to some silty shale. Sand, 10%, unaggregated as above. Shale, 10%, N5, soft	305 – 314
36	Siltstone, 70%, N8-N6, coarse-grained silt to very fine-grained sand, some coarse sand 330-350, 10% is slightly to somewhat calcareous. Shale, N6-N4, also greenish- (5GY/6) 330-350, in small part silty	314 – 350
10	Sand, 60%, fine- to coarse-grained, N8-N9, very slightly calcareous. Shale, 40%, N5 to greenish-gray (5G5/1), in large part silty and grading to argillaceous siltstone	350 – 360
10	Sand, 50%, coarse-grained, unaggregated, N7-N8. Siltstone, 50%, bluish-greenish-gray (5BG5/1) and medium-light-greenish-gray (5G7/1), somewhat argillaceous and grading to silty shale	360 – 370
17	Shale, 95%, N5, mostly greenish-gray (5G5/0.5) and silty from 370-76, 10% grayish- to pale-red (104-6/2) from 381-87. Sand, 5%, as above	370 – 387
5	Shale, 90%, N5-greenish-gray (5G5-6/0.5), slightly silty. Sandstone, 10%, very fine-grained sand to coarse-grained silt, occasional coarse to very coarse fragment	387 – 392

Thickness Feet	*Description of Strata*	*Depth in Feet*
6	Sand, 65%, medium- to coarse- and some fine-grained, unaggregated, N8, subangular. Shale, 35%, N5-N6 and greenish-gray (5G5-6/0.5), in part silty	392 – 398
30	Shale, N5-N6 and greenish-gray (5G5/0.5), in small part slightly silty, mostly silty from 402-408. 5% coarse- to very coarse-grained sand fragments 398-408. 10% sandstone from 418-428, very fine- to occasional fine-grained sand to coarse-grained silt, N5-N7	398 – 428
8	Shale, 60%, N5-N6, soft. Sandstone, 40%, very fine-grained sand to coarse-grained silt, N7-N8 and medium-light to light-greenish-gray (5G7-8/1), in part slightly calcareous	428 – 436
7	Samples missing—probably sandstone	436 – 443
7	Similar to 428–436 but shale 25% and silty, sandstone 75%	443 – 450
8	Silty shale and sandstone similar to above, 10%. Shale, 70%, grayish-red-purple (5RP4/2), in part silty. Siltstone, 20%, (5P-RP4/2) grayish-purple to grayish-red-purple, argillaceous	450 – 458
7	Shale, 35%, similar to above, but few pieces silty. Shale, 65%, bluish-green-gray (5BG5/0.5), soft	458 – 465
	Base of Cattaraugus Formation, 461 feet	
81	Shale, N5-N4, occasionally brownish-gray (5YR5/1) 465–506, trace of grayish-red to moderate-dusky-red (5R4/2-4) 465–485 and 526–33, slightly silty to silty. Trace of N7-N6 siltstone 492–526	465 – 546
7	Siltstone, 65%, greenish-gray (5G6/0.5) to N6, argillaceous, grading to silty shale, 10%-20% contains shell fragments. Shale, 35%, N5, soft	546 – 553
5	Shale, N5 to greenish-gray (5G5/0.5), silty to somewhat silty, 10% somewhat calcareous from shell fragments	553 – 558
	Pink Rock, 338 feet	558
12	Very silty shale to argillaceous siltstone, 65% reddish-purple-gray to grayish-red-purple (5RP4/1-2), 35% medium-light-greenish- to greenish-gray (5G7-6/1), containing brachiopod fragments and crinoid columnals	558 – 570
28	Argillaceous siltstone, 40%, grading to 40% silty shale, reddish-purple-gray to grayish-red-purple (5RP4/1-0.5-2). Shale, 20%, greenish-gray, (5G-GY6/0.5), in part silty, grading to argillaceous siltstone. Both lithologies contain shell fragments but more common in green siltstone	570 – 598
37	Shale, reddish-purple-gray (5RP4/0.5-1), in large part silty and grading into little argillaceous siltstone. Great	

Thickness Feet	*Description of Strata*	*Depth in Feet*
	deal of interbedded N5 to greenish-gray (5G5-6/0.5) shale, in small part silty from 98-615, largely silty from 615-635 and grading to some argillaceous siltstone	598 – 635
15	Siltstone, 70%, argillaceous, reddish-purple-gray (5RP4/1-0.5), grading to some silty shale. Shale, 30%, mostly N5-greenish-gray (5G5/0.5) and in part silty, and also 5RP4/1	635 – 650
6	Siltstone, 35%, similar to above. Siltstone, 65%, greenish-gray (5GY6/1-0.5) somewhat to slightly silty, very slightly calcareous	650 – 656
18	Shale, N5 to greenish-gray (5G5-6/0.5) in part silty, grading to some argillaceous siltstone. Considerable interbedded reddish-purple-gray (5RP4/1-0.5) shale, in part silty. Trace of shell fragments in both red and green lithologies. Considerable interbedded siltstone 667-74, greenish-gray (5GY6/0.5) to N6, in large part argillaceous	656 –674
7	Samples missing	674 –681
9	Similar to 656-674 but 60% siltstone, 20% N5-5G5/0.5 shale, 20% 5RP4/1 shale	681 –690
14	Siltstone, 50%, N5 to greenish-gray (5G-GY5/0.5), in large part argillaceous, shell fragments and crinoid columnals common. Shale, N5, in part silty	690 – 704
16	Shale, 80%, N5-N6 and greenish-gray (5G5-6/0.5), in large part silty and grading to some argillaceous siltstone with few shell fragments. Shale, 20%, reddish-purple-gray (5RP4/0.5), in part silty	704 – 720
13	Argillaceous siltstone grading to silty shale, 75% reddish-purple-gray (5RP4/1-0.5), 25% N5 to greenish-gray (5GY5/0.5), in part slightly calcareous	720 – 733
8	Similar to above but siltstone 40%, 20% 5RP4/1-0.5 and 20% 5GY5/0.5, plus 60% shale, 30% 5RP4/1 and 30% 5G5/1	733 – 741
11	Shale, 50%, N5, in part silty and grading to some argillaceous siltstone. Shale, 30%, grayish-red-purple to reddish-purple-gray (5RP4/2-1). Siltstone, 20%, greenish gray (5G-GY6/1), slightly argillaceous. Shell fragments and calcite rhombs common	741 – 752
7	Siltstone, 70%, reddish-purple-gray (5RP4/0.5) to greenish-gray (5GY-6/0.5), argillaceous, containing shell fragments, grading to silty shale. Shale 30%, N5 to 5RP4/0.5, in part slightly silty	752 –759
20	Siltstone, 50%, medium-light-greenish- to greenish-gray (5GY7-6/1-0.5), in part argillaceous, fossil fragments and calcite fragments common. Shale, 50%, N5-N6, in part silty	759 – 779

Thickness Feet	*Description of Strata*	*Depth in Feet*
16	Argillaceous siltstone and silty shale, 90%, greenish-gray (5GY6/0.5) to N5, with calcite and fossil fragments common, 10% reddish-purple-gray (5RP4/1-0.5)	779 – 795
8	Similar to above but 50% greenish-gray and 50% reddish-purple-gray. No fossils noted	795 – 803
6	Siltstone, 75%, reddish-purple-gray (5RP4/1), argillaceous. Shale, 25%, N5 to greenish-gray (5G5/0.5), in large part silty, grading to argillaceous siltstone	803 – 809
12	Shale, 90%, grayish-red-purple (5RP4/2), in large part silty. Shale, 10%, N5 to greenish-gray (5G5/0.5), in large part silty	809 – 821
10	Similar to above but grayish-red-purple shale 20%, greenish-gray shale, 80%. Shell fragments common	821 –831
65	Argillaceous siltstone and silty shale, approximately 50% reddish-purple-gray (5RP4/1-0.5) and 50% greenish-gray (5G-GY6-5/0.5-1), very slightly to slightly calcareous, shell fragments common 831-40 and 887-94. Some interbedded, non-silty, grayish-red-purple (5RP4/2) shale from 840-858	831 – 896
	Base of Pink Rock	896
8	Siltstone, medium-light-greenish- to very light-olive-gray (5G-GY-Y7/1), in part coarse-grained, slightly argillaceous, fossil fragments common, 10% calcareous. Little interbedded shale, greenish-gray (5G-GY6/1), in large part silty. Considerable interbedded soft N5-N4 shale from 899-904	894 – 904
15	Siltstone, 85%, similar to above but no shell fragments. Shale, 15%, N5, in part silty	904 – 919
30	Shale, N5 to occasional brownish-gray (5YR5/1), mostly soft but in part slightly to somewhat silty and few pieces very fine sandy. Siltstone, 5% at top to 20% at base, greenish-gray (5G6/1-0.5), coarse-grained, few pieces calcareous	919 – 949
16	Siltstone, 70%, argillaceous to slightly argillaceous, greenish-gray (5G-GY6/1) to N5-N6, in part micaceous. Shale, 30%, N5, soft, micaceous	949 – 965
5	Shale, 90%, N5, soft. Siltstone, 10%, coarse-grained, greenish-gray (5GY6/0.5), slightly argillaceous	965 – 970
6	Siltstone, 60%, similar to above but also light-greenish-gray (5G8/1) and in small part very fine sandy. Shale, 40%, similar to above	970 – 976
18	Similar to above but siltstone 90%, 5G6-5/1, in part argillaceous, in part very fine sandy, and 10% is calcareous and contains shell fragments, shale 10%	976 – 994
10	Sandstone, 75%, very fine-grained sand to coarse-grained silt, containing rare rounded medium sand grain, me-	

Thickness Feet	*Description of Strata*	*Depth in Feet*
	dium-light-greenish- to yellowish-gray (5G7/1-5Y8/1), 5% calcareous. Shale, 25%, N6-N5, soft	994 – 1004
13	Siltstone, 60%, coarse-grained, medium-light-greenish-gray (5G7/1) to N6, slightly micaceous, grading to trace of very fine-grained, very light-olive-gray (5Y7/1) sandstone. Shale, 40%, N5, soft	1004 – 1017
17	Similar to above but siltstone 10%, with no sandstone, shale 90%	1017 – 1034
5	Similar to 1017-1034 but shale 50%, siltstone 50%	1034 – 1039
5	Samples missing	1039 – 1044
14	Shale, N5, grading to some siltstone, in small part very fine sandy	1044 – 1058
29	Shale, N5, soft, in small part silty 1058-79	1058 – 1087
	Top of Glade rocks 1087	
7	Similar to above plus 60% siltstone, greenish- to medium-light-greenish-gray (5GY5-7/0.5-1), in part argillaceous and somewhat calcareous. Trace of shell fragments	1087 – 1094
8	Shale, 90%, greenish-gray (5G5/0.5), silty, containing trace of shell fragments. Shale, 10%, N5-5G5/0.5, soft	1094 – 1102
	Top of Glade siltstone 1102	
40	Siltstone, greenish-gray (5GY6-5/1), argillaceous to somewhat argillaceous, slightly calcareous, grading to very silty shale, fossil fragments common 1125-32. Very little interbedded N5 shale. Top of Glade sandstone 1126	1102 – 1142
6	Sandstone, very fine- to fine-grained, rare medium grain, N7 to very light-olive-gray (5Y7/1), in part calcareous	1142 – 1148
8	Sandstone, 60%, very fine-grained sand to coarse-grained silt, N7 to medium-light-greenish- to very light-olive-gray (5G-Y7/0.5-1). Shale, 40%, N5-N6, soft. Trace of subrounded medium to coarse-grained sandstone	1148 – 1156
6	Sandstone, similar to above, with trace of N5-N6 shale near top	1156 – 1162
14	Sandstone, very fine- to occasional fine-grained, light-greenish-gray (5GY8/1-0.5), slightly micaceous (muscovite and biotite)	1162 – 1176
3	Shale, N5-N6, clayey	1176 – 1179
4	Sandstone, very fine-grained sand to coarse-grained silt, medium-light- to light-greenish-gray (5GY7-8/1), slightly micaceous (muscovite and biotite), 10% somewhat calcareous	1179 – 1183
5	Samples missing—probably mostly shale from character of gamma ray log	1183 – 1188
16	Sandstone, very fine-grained sand to coarse-grained silt, light-greenish-gray (5GY8/1), slightly micaceous	1188 – 1204

Top of Glade transitional zone 1204

Thickness Feet	*Description of Strata*	*Depth in Feet*
33	Sandstone, 50%, similar to above, but medium-light-greenish-gray (5GY7/1), few pieces to 10% somewhat calcareous. Shale, 50%, N5-N6, soft	1204 – 1237

Top of Clarendon rocks and Clarendon Stray sandstone 1219

Thickness Feet	*Description of Strata*	*Depth in Feet*
9	Siltstone, 80%, coarse-grained silt to very fine-grained sand, 5GY7-8/1, in small part very slightly calcareous. Shale, 20%, N6-N5, soft	1237 –1246
2	Shale, N6, soft	1246 – 1248

Top of Clarendon sandstone 1248

Thickness Feet	*Description of Strata*	*Depth in Feet*
10	Sandstone, very fine-grained sand to coarse-grained silt, medium-light-greenish-gray (5GY7/1) in part slightly micaceous, 10% slightly calcareous	1248 – 1258
2	Shale, N6, soft	1258 – 1260
5	Sandstone, similar to 1248-1258	1260 – 1265
5	Sandstone as above 40%, grading to silty sandstone. Shale, 60%, N6, soft	1265 – 1270
6	Siltstone, 70%, coarse-grained, greenish-gray (5GY6/0.5) to N6, slightly to somewhat argillaceous. Sandstone, 30%, very fine-grained, light-greenish-gray (5GY8/1-0.5), few pieces calcareous	1270 – 1276
18	Siltstone, 80%, greenish-gray (5GY6-5/1-0.5), argillaceous to somewhat argillaceous, 5-10% somewhat calcareous to calcareous, some brachiopod fragments 1289-94. Shale, 20%, N5-N4	1276 – 1294

Base of Clarendon rocks 1244

Thickness Feet	*Description of Strata*	*Depth in Feet*
10	Shale, N5 to greenish-gray (5G-GY5/0.5) grading to some argillaceous siltstone, slightly calcareous	1294 – 1304
28	Shale, N5-N6 and greenish gray (5GY5-6/0.5), soft. Trace of N6-N5 glassy quartzitic siltstone to sandstone and trace of coarse sand grains 1325-1332	1304 – 1332
2	Sandstone, coarse-grained, subrounded to subangular	1332 –1334
11	Shale, 80%, greenish-gray (5GY6/0.5), in part silty. Siltstone, 20%, coarse-grained silt to very fine-grained sand, medium-light-greenish-gray (5GY7/0.5)	1334 – 1345
5	Coarse-grained siltstone to very fine-grained sandstone, N6-N8 and greenish to light-greenish-gray (5G-GY6-8/0.5), in part slightly argillaceous, very slightly calcareous	1345 –1350
11	Siltstone, 90%, (5GY6-7/0.5) greenish- to medium-light greenish-gray, argillaceous to slightly argillaceous, grading to silty shale. Shale, 10%, N5-N6, soft	1350 – 1361
9	Shale, N5-N6, silty grading to some argillaceous siltstone	1361 – 1370

Thickness Feet	Description of Strata	Depth in Feet
5	Similar to above, but grading to great deal argillaceous siltstone	1370 – 1375
8	Siltstone, 75%, coarse-grained, in part very fine sandy, greenish- to medium-light-greenish-gray (5GY6-7/0.5), argillaceous to slightly argillaceous, very slightly calcareous. Shale, 25%, N5-N6, in part silty	1375 – 1383
5	Sandstone, 75%, very fine-grained sand to coarse-grained silt, light-greenish-gray (5GY8/1-0.5), friable, slightly micaceous, very slightly calcareous. Shale, 25%, N6, soft	1383 – 1388
3	Siltstone, 70%, largely coarse-grained, N6-N8, in large part argillaceous, very slightly calcareous. Shale, 30% N6, soft	1388 – 1391
	Total depth	1391

APPENDIX B

Analyses of crude oils from the Warren, Butler, and Zelienople quadrangles, Pennsylvania

REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51005

IDENTIFICATION

Clarendon field	South Penn Oil Co.	Pennsylvania
Clarendon sand, Upper Devonian	No. 38	Warren County, Mead Twp.
981–1,006 feet	Lot 106	Warren Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.785 A.P.I. gravity, 48.8° Pour point, °F., below 5
Sulfur, percent, less that 0.1 Color, N.P.A. No. 2½
Saybolt Universal visosity at 100°F., 36 sec.

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 737 mm. Hg
First drop, 27°C (81°F.)

Fraction No.	*Cut at °C.*	*Cut at °F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I., 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
1	50	122	5.7	5.7	0.627	94.2	—	—		
2	75	167	3.9	9.6	.659	83.2	2.3	62.6		
3	100	212	5.7	15.3	.703	69.8	13	58.2		
4	125	257	7.5	22.8	.730	62.3	17	56.0		
5	150	302	5.9	28.7	.749	57.4	18	56.4		
6	175	347	6.0	34.7	.763	54.0	18	59.0		
7	200	392	5.4	40.1	.774	51.3	17	65.0		
8	225	437	5.1	45.2	.785	48.8	17	65.0		
9	250	482	5.3	50.5	.797	46.0	17	75.0		
10	275	527	6.2	56.7	.810	43.2	19	79.0		
STAGE 2—Distillation continued at 40 mm. Hg										
11	200	392	3.0	59.7	0.823	40.4	21	84.4	42	20
12	225	437	5.1	64.8	.832	38.6	21	88.2	45	35
13	250	482	4.7	69.5	.841	36.8	22		55	55
14	275	527	4.1	73.6	.849	35.2	23		73	70
15	300	572	4.7	78.3	.858	33.4	24		115	80
Residuum			17.2	95.5	.890	27.5				

Carbon residue of residuum, 0.9 percent; carbon residue of crude, 0.2 percent

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	15.3	0.663	81.9	
Total gasoline and naphtha	40.1	0.718	65.6	
Kerosene distillate	16.6	.798	45.8	
Gas oil	8.0	.828	39.4	
Nonviscous lubricating distillate	9.7	.836–.855	37.8–34.0	50–100
Medium lubricating distillate	3.9	.855–.863	34.0–32.5	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	17.2	.890	27.5	
Distillation loss	4.5			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51006

IDENTIFICATION

Clarendon field	Seavy and Sharp	Pennsylvania
Clarendon sand, Upper Devonian	White No. 20	Warren County, Mead Twp.
992–1,016 feet	Lot 498	Warren Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.794 A.P.I. gravity, 46.7° Pour point, °F., below 5
Sulfur, percent, less than 0.1 Color, N.P.A. No. 3
Saybolt Universal viscosity at 100°F., 37 sec.

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 741 mm. Hg
First drop, 28°C. (82°F.)

Fraction No.	*Cut at*		*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I., 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
	°C.	*°F.*								
1	50	122	3.1	3.1	0.636	91.0	—	—		
2	75	167	3.5	6.6	.657	83.9	1.3	62.4		
3	100	212	5.7	12.3	.703	69.8	13	58.2		
4	125	257	7.1	19.4	.730	62.3	17	55.8		
5	150	302	6.1	25.5	.749	57.4	18	55.8		
6	175	347	6.1	31.6	.764	53.7	19	59.0		
7	200	392	5.0	36.6	.775	51.1	18	64.0		
8	225	437	5.0	41.6	.784	49.0	16	69.8		
9	250	482	5.4	47.0	.797	46.0	17	74.0		
10	275	527	6.1	53.1	.808	43.6	18	79.0		
STAGE 2—Distillation continued at 40 mm. Hg										
11	200	392	2.7	55.8	0.822	40.6	20	83.2	42	15
12	225	437	5.7	61.5	.831	38.8	21	86.0	44	35
13	250	482	4.7	66.2	.840	37.0	22		52	50
14	275	527	4.8	71.0	.848	35.4	22		68	70
15	300	572	4.8	75.8	.858	33.4	24		110	80
Residuum			19.8	95.6	.888	27.9				

Carbon residue of residuum, 0.9 percent; carbon residue of crude, 0.2 percent

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	12.3	0.673	78.8	
Total gasoline and naphtha	36.6	0.726	63.4	
Kerosene distillate	16.5	.797	46.0	
Gas oil	9.4	.827	39.6	
Nonviscous lubricating distillate	9.8	.837–.855	37.6–34.0	50–100
Medium lubricating distillate	3.5	.855–.863	34.0–32.5	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	19.8	.888	27.9	
Distillation loss	4.4			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 23406

IDENTIFICATION

F. C. Eaton well No. 3	Warren Quadrangle	Item 55
710–750 feet	Tiona Field	Pennsylvania
F. C. Eaton	Glade sand	Warren County
		Glade Township

GENERAL CHARACTERISTICS

Specific gravity, 0.801
Sulphur percent, 0.15
Saybolt Universal viscosity at 100°F., 38 sec.

A.P.I. gravity, 45.2°
Color, N.P.A. No. 6

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

Dry distillation Barometer 745 mm. First drop: 30°C. (86°F.)

Temperature, °C.	*Percent cut*	*Sum, percent*	*Specific gravity of cut*	*A.P.I. of cut*	*Viscosity at 100°F.*	*Cloud test, °F.*	*Temperature, °F.*
Up to 50	1.4	1.4	0.680	76.6			Up to 122
50– 75	2.6	4.0					122–167
75–100	5.3	9.3	.698	71.2			167–212
100–125	8.8	18.1	.727	63.1			212–257
125–150	7.9	26.0	.746	58.2			257–302
150–175	6.0	32.0	.762	54.2			302–347
175–200	6.3	38.3	.776	50.9			347–392
200–225	3.7	42.0	.787	48.3			392–437
225–250	5.6	47.6	.797	46.0			437–482
250–275	6.1	53.7	.812	42.8			482–527
Vacuum distillation at 40 mm.							
Up to 200	3.8	3.8	0.834	38.2	40	20	Up to 392
200–225	5.1	8.9	.839	37.2	46	35	392–437
225–250	7.7	16.6	.859	33.2	69	60	437–482
250–275	5.7	23.3	.864	32.3	87	70	482–527
275–300	5.7	29.0	.879	29.3	120	90	527–572

Carbon residue or residuum 1.6 percent; carbon residue of crude 0.3 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	9.3	0.691	73.3	
Total gasoline and naphtha	38.3	0.736	60.8	
Kerosene distillate	15.4	.801	45.2	
Gas oil	7.5	.836	37.8	
Nonviscous lubricating distillate	15.1	.842–.870	36.6–31.1	50–100
Medium lubricating distillate	6.4	.870–.886	31.1–28.2	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	16.3	.898	26.1	
Distillation loss	1.0			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 23407

IDENTIFICATION

Oil Field Ref. Co. No. 12
956–974 Approx. feet
Oil Field Co.

Warren Quadrangle
Tiona Field
Clarendon sand

Item 56
Pennsylvania
Warren County
Mead Township

GENERAL CHARACTERISTICS

Specific gravity, 0.804
Sulphur percent, 0.14
Saybolt Universal viscosity at 100°F., 40 sec.

A.P.I. gravity, 44.5°
Color, N.P.A. No. 4

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

Dry distillation Barometer 746 mm. First drop: 30°C. (86°F.)

Temperature, °C.	*Percent cut*	*Sum, percent*	*Specific gravity of cut*	*A.P.I. of cut*	*Viscosity at 100°F.*	*Cloud test, °F.*	*Temperature, °F.*
Up to 50							Up to 122
50– 75	1.9	1.9	0.698	71.2			122–167
75–100	2.9	4.8					167–212
100–125	5.9	10.7	.729	62.6			212–257
125–150	7.7	18.4	.747	57.9			257–302
150–175	6.6	25.0	.762	54.2			302–347
175–200	5.3	30.3	.774	51.3			347–392
200–225	5.3	35.6	.783	49.2			392–437
225–250	5.9	41.5	.795	46.5			437–482
250–275	7.5	49.0	.809	43.4			482–527
Vacuum distillation at 40 mm.							
Up to 200	4.1	4.1	0.833	38.4	40	20	Up to 392
200–225	6.3	10.4	.839	37.2	46	35	392–437
225–250	5.5	15.9	.847	35.6	61	55	437–482
250–275	6.9	22.8	.859	33.2	77	70	482–527
275–300	4.9	27.7	.875	30.2	115	90	527–572

Carbon residue of residuum 1.0 percent; carbon residue of crude 0.2 percent.

*APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	4.8	0.698	71.2	
Total gasoline and naphtha	30.3	0.744	58.7	
Kerosene distillate	18.7	.797	46.0	
Gas oil	8.8	.836	37.8	
Nonviscous lubricating distillate	14.0	.841–.868	36.8–31.5	50–100
Medium lubricating distillate	4.9	.868–.882	31.5–28.9	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	21.7	.890	27.5	
Distillation loss	1.6			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 37191

IDENTIFICATION

Well No. OA-8	Warren Quadrangle	Item 53
1,044–1,076 feet	Clarendon Field	Pennsylvania
Belleview Oil	Clarendon sand	Warren County
		Mead Twp., Lot 531

GENERAL CHARACTERISTICS

Specific gravity, 0.789	A.P.I. gravity, 47.8°
Sulphur percent, less than 0.1	Color, N.P.A. No. 4
Saybolt Universal viscosity at 77°F., 38 sec.	
Saybolt Universal viscosity at 100°F., 37 sec.	

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

Dry distillation   Barometer 741 mm.   First drop: 34°C. (93°F.)

Temperature, °C.	*Percent cut*	*Sum, percent*	*Specific gravity of cut*	*A.P.I. of cut*	*Viscosity at 100°F.*	*Cloud test, °F.*	*Temperature, °F.*
Up to 50	4.9	4.9	0.641	89.3			Up to 122
50– 75	3.7	8.6	.654	84.9			122–167
75–100	5.2	13.8	.697	71.5			167–212
100–125	7.1	20.9	.726	63.4			212–257
125–150	6.1	27.0	.745	58.4			257–302
150–175	5.3	32.3	.761	54.4			302–347
175–200	4.9	37.2	.774	51.3			347–392
200–225	4.9	42.0	.784	49.0			392–437
225–250	5.2	47.3	.797	46.0			437–482
250–275	6.7	54.0	.809	43.4			482–527
Vacuum distillation at 40 mm.							
Up to 200	3.7	3.7	0.827	39.6	40	20	Up to 392
200–225	5.0	8.7	.833	38.4	45	35	392–437
225–250	4.5	13.2	.841	36.8	53	55	437–482
250–275	5.0	18.2	.850	35.0	74	70	482–527
275–300	4.6	22.8	.859	33.2	115	85	527–572

Carbon residue or residuum 1.6 percent; carbon residue of crude 0.3 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	°A.P.I.	*Viscosity*
Light gasoline	13.8	0.666	81.0	
Total gasoline and naphtha	37.2	0.718	65.6	
Kerosene distillate	16.8	.798	45.8	
Gas oil	9.2	.831	38.8	
Nonviscous lubricating distillate	9.6	.838–.856	37.4–33.8	50–100
Medium lubricating distillate	4.0	.856–.863	33.8–32.5	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	19.2	.894	26.8	
Distillation loss	4.0			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51012

IDENTIFICATION

Unionville field	C. C. Miller et al.	Pennsylvania
Hundred foot sand, Devonian	No. 1 Harry Snyder	Butler County, Center Twp.
1,300–1,399 feet		Butler Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.827 A.P.I. gravity, 39.6° Pour point, °F. below 5
Sulfur, percent less that 0.1 Color, N.P.A. No. 5
Saybolt Universal viscosity at 77°F., 62 sec.; at 100°F., 52 sec.

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 762 mm. Hg.
First drop, 147°C. (297°F.)

Fraction No.	*Cut at*		*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
	°C.	*°F.*								
1	50	122								
2	75	167								
3	100	212								
4	125	257								
5	150	302								
6	175	347	5.3	5.3	0.757	55.4	—	66.4		
7	200	392	8.0	13.3	.768	52.7	14	69.0		
8	225	437	7.9	21.2	.780	49.9	15	74.0		
9	250	482	8.3	29.5	.793	46.9	15	78.4		
10	275	527	9.8	39.3	.804	44.5	16	82.6		
STAGE 2—Distillation continued at 40 mm. Hg.										
11	200	392	5.6	44.9	0.817	41.7	18	87.0	40	20
12	225	437	9.6	54.5	.826	39.8	19	90.2	43	40
13	250	482	8.0	62.5	.835	38.0	19		51	55
14	275	527	6.7	69.2	.845	36.0	21		68	70
15	300	572	7.2	76.4	.853	34.4	22		105	85
Residuum			23.4	99.8	.885	28.4				

Carbon residue of residuum, 1.4 percent; carbon residue of crude, 0.4 percent

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	00.0	0.000	00.0	
Total gasoline and naphtha	13.3	0.764	53.7	
Kerosene distillate	26.0	.793	46.9	
Gas oil	18.0	.824	40.2	
Nonviscous lubricating distillate	14.6	.834–.852	38.2–34.6	50–100
Medium lubricating distillate	4.5	.852–.857	34.6–33.6	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	23.4	.885	28.4	
Distillation loss	.2			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51013

IDENTIFICATION

Saxonburgh field	H. H. Battenfelter,	Pennsylvania
Hundred foot sand,	et al.	Butler County, Jefferson Twp.
Upper Devonian	No. 1	Butler Quadrangle
1,498–1,505 feet	Lulu Heginbotham	

GENERAL CHARACTERISTICS

Specific gravity, 0.806 A.P.I. gravity, 44.1° Pour point, °F. 15
Sulfur, percent, less than 0.1 Color, N.P.A. No. 4
Saybolt Universal viscosity at 100°F., 39 sec.

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 762 mm. Hg.
First drop, 62°C. (144°F.)

Fraction No.	*Cut at*		*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I., 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
	°C.	*°F.*								
1	50	122								
2	75	167								
3	100	212	4.0	4.0	0.693	72.7	—	62.8		
4	125	257	5.4	9.4	.727	63.1	16	60.2		
5	150	302	5.5	14.8	.745	58.4	17	61.2		
6	175	347	6.7	21.6	.765	53.5	19	62.4		
7	200	392	6.0	27.6	.778	50.4	19	65.9		
8	225	437	7.9	35.5	.787	48.3	18	72.8		
9	250	482	11.1	46.6	.793	46.9	15	79.0		
10	275	527	9.9	56.5	.802	44.9	15	83.4		

STAGE 2—Distillation continued at 40 mm. Hg.

Fraction No.	*°C.*	*°F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I., 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
11	200	392	5.5	62.0	0.814	42.3	17	87.0	39	20
12	225	437	7.5	69.5	.825	40.0	18	91.0	44	35
13	250	482	5.6	75.1	.833	38.4	19		51	55
14	275	527	5.3	80.4	.843	36.4	20		68	70
15	300	572	4.4	84.8	.852	34.6	21		100	85
Residuum			15.0	99.8	.803	28.8				

Carbon residue of residuum, 1.2 percent; carbon residue of crude, 0.2 percent

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	4.0	0.693	72.7	
Total gasoline and naphtha	27.6	0.746	58.2	
Kerosene distillate	28.9	.794	46.7	
Gas oil	15.0	.821	40.9	
Nonviscous lubricating distillate	11.1	.832–.852	38.6–34.6	50–100
Medium lubricating distillate	2.2	.852–.856	34.6–33.8	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	15.0	.883	28.8	
Distillation loss	.2			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51014

IDENTIFICATION

McCalmont field	Alfred Eckstein	Pennsylvania
Third sand, Upper Devonian	No. 5. Pearce Heirs	Butler County, Butler Twp.
1,767–1,794 feet		Butler Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.799 A.P.I. gravity, 45.6° Pour point, °F. below 5
Sulfur, percent, less than 0.1 Color, N.P.A. No. 5
Saybolt Universal viscosity at 100°F., 38 sec.

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 760 mm. Hg.
First drop, 28°C. (82°F.)

Fraction No.	*Cut at °C.*	*Cut at °F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
1	50	122	1.6	1.6	0.654	84.9	—	—		
2	75	167	2.4	4.0						
3	100	212	4.9	8.9	.694	72.4	8.9	62.8		
4	125	257	7.7	16.6	.722	64.5	13	60.8		
5	150	302	7.3	23.9	.742	59.2	15	60.8		
6	175	347	7.0	30.9	.758	55.2	16	63.0		
7	200	392	5.9	36.8	.771	52.0	16	67.0		
8	225	437	6.0	42.8	.782	49.5	15	72.6		
9	250	482	6.0	48.8	.793	46.9	15	76.7		
10	275	527	7.3	56.1	.805	44.3	16	81.4		
STAGE 2—Distillation continued at 40 mm. Hg.										
11	200	392	3.7	59.8	0.819	41.3	19	—	40	20
12	225	437	6.5	66.3	.829	39.2	20	89.6	45	35
13	250	482	5.3	71.6	.840	37.0	22		54	55
14	275	527	5.3	76.9	.849	35.2	23		73	75
15	300	572	6.1	83.0	.859	33.0	25		125	90
Residuum			16.6	99.6	.901	25.6				

Carbon residue of residuum, 1.6 percent; carbon residue of crude, 0.3 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	8.9	0.676	77.8	
Total gasoline and naphtha	36.8	0.730	62.3	
Kerosene distillate	19.3	.794	46.7	
Gas oil	10.3	.826	39.8	
Nonviscous lubricating distillate	10.9	.835–.854	38.9–34.2	50–100
Medium lubricating distillate	5.7	.854–.864	34.2–32.3	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	16.6	.901	25.6	
Distillation loss	.4			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51015

IDENTIFICATION

Hooker field
Speechley sand, Upper Devonian
2,393–2,412 feet

J. F. MacKay
No. 12
J. H. Thompson

Pennsylavnia
Butler County, Concord Twp.
Butler Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.816 A.P.I. gravity, 41.9°
Sulfur, percent, less than 0.1
Saybolt Universal viscosity at 100°F., 44 sec.

Pour point, °F. below 5
Color, N.P.A. No. 4½

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 760 mm. Hg.
First drop, 79°C. (174°F.)

Fraction No.	*Cut at*		*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I., 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
	°C.	*°F.*								
1	50	122								
2	75	167								
3	100	212	1.7	1.7	0.705	69.2	—	—		
4	125	257	5.6	7.3	.725	63.7	15	59.9		
5	150	302	6.1	13.4	.741	59.5	15	60.4		
6	175	347	7.2	20.6	.757	55.4	15	63.0		
7	200	392	6.6	27.2	.769	52.5	15	68.0		
8	225	437	6.3	33.5	.781	49.7	15	73.6		
9	250	482	7.0	40.5	.793	46.9	15	76.4		
10	275	527	7.2	47.7	.805	44.3	16	81.0		
STAGE 2—Distillation continued at 40 mm. Hg.										
11	200	392	3.2	50.9	0.817	41.7	18	85.0	39	20
12	225	437	7.7	58.6	.826	39.8	19	88.4	43	35
13	250	482	6.3	64.9	.838	37.4	21		52	50
14	275	527	5.9	70.8	.847	35.6	22		71	65
15	300	572	5.5	76.3	.858	33.4	24		110	75
Residuum			22.9	99.2	.894	26.8				

Carbon residue of residuum, 1.4 percent; carbon residue of crude, 0.4 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	1.7	0.705	69.2	
Total gasoline and naphtha	27.2	0.746	58.2	
Kerosene distillate	20.5	.794	46.7	
Gas oil	12.5	.825	40.0	
Nonviscous lubricating distillate	11.9	.835–.855	38.0–34.0	50–100
Medium lubricating distillate	4.2	.855–.863	34.0–32.5	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	22.9	.894	26.8	
Distillation loss	.8			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51016

IDENTIFICATION

Greece City field
Fourth sand, Upper Devonian
1,399–1,410 feet

T. S. Clark
No. 3 T. S. Clark

Pennsylvania
Butler County, Concord Twp.
Butler Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.805 A.P.I. gravity, 44.3°
Sulfur, percent, less than 0.1
Saybolt Universal viscosity at 100°F., 39 sec.

Pour point, °F. below 5
Color, N.P.A. No. 5

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 760 mm. Hg.
First drop, 34°C. (93°F.)

Fraction No.	*Cut at* *°C.*	*°F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
1	50	122	0.4	0.4	0.663	81.9	—	63.0		
2	75	167	2.3	2.7						
3	100	212	3.7	6.4	.701	70.4	12	60.4		
4	125	257	7.7	14.1	.723	64.2	14	58.9		
5	150	302	6.4	20.5	.745	58.4	17	59.3		
6	175	347	7.7	28.2	.761	54.4	17	62.4		
7	200	392	5.8	34.0	.773	51.6	17	67.4		
8	225	437	6.4	40.4	.784	49.0	16	72.8		
9	250	482	6.5	46.9	.796	46.3	17	77.4		
10	275	527	6.9	53.8	.808	43.6	18	82.0		
STAGE 2—Distillation continued at 40 mm. Hg.										
11	200	392	4.6	58.4	0.821	40.9	20	86.6	41	25
12	225	437	6.4	64.8	.831	38.8	21	90.4	46	40
13	250	482	5.2	70.0	.840	37.0	22		56	60
14	275	527	6.2	76.2	.852	34.6	24		76	80
15	300	572	6.7	82.7	.859	33.2	25		130	90
Residuum			16.6	99.5	.893	27.0				

Carbon residue of residuum, 1.7 percent; carbon residue of crude, 0.3 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	6.4	0.685	75.1	
Total gasoline and naphtha	34.0	0.737	60.5	
Kerosene distillate	19.8	.796	46.3	
Gas oil	10.2	.826	39.8	
Nonviscous lubricating distillate	12.0	.835–.855	38.0–34.0	50–100
Medium lubricating distillate	6.9	.855–.863	34.0–32.5	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	16.6	.893	27.0	
Distillation loss	.5			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51017

IDENTIFICATION

Queen Junction field	G. T. Whaley &	Pennsylvania
Shira sand, Upper Devonian	H. O. Porter	Butler County, Clay Twp.
1,405–1,412 feet	No. 1 Nancy Cochran	Butler Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.796 A.P.I. gravity, 46.3° Pour point, °F., below 5
Sulfur, percent, less than 0.1 Color, N.P.A. No. 6
Saybolt Universal viscosity at 100°F., 34 sec.

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 760 mm. Hg.
First drop, 28°C. (82°F.)

Fraction No.	*Cut at °C.*	*Cut at °F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
1	50	122	2.6	2.6	0.664	81.9	—	—		
2	75	167	3.0	5.6						
3	100	212	4.9	10.5	.692	73.0	8.0	62.4		
4	125	257	8.5	19.0	.721	64.8	13	60.8		
5	150	302	7.0	26.0	.741	59.5	15	61.2		
6	175	347	7.7	33.7	.759	54.9	16	62.2		
7	200	392	5.0	38.7	.775	51.1	18	65.7		
8	225	437	5.8	44.5	.786	48.5	17	71.0		
9	250	482	6.2	50.7	.796	46.3	17	77.4		
10	275	527	7.5	58.2	.807	43.8	17	81.0		

STAGE 2—Distillation continued at 40 mm. Hg.

Fraction No.	*Cut at °C.*	*Cut at °F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
11	200	392	3.8	62.1	0.819	41.3	19	85.4	40	15
12	225	437	5.9	68.0	.830	39.0	20	89.2	44	35
13	250	482	5.0	73.0	.838	37.4	21		53	55
14	275	527	5.0	78.0	.848	35.4	22		73	70
15	300	572	3.8	81.8	.861	32.8	26		120	80
Residuum			17.8	99.6	.882	28.9				

Carbon residue of residuum, 1.5 percent; carbon residue of crude, 0.3 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	10.5	0.677	77.5	
Total gasoline and naphtha	38.7	0.727	63.1	
Kerosene distillate	19.5	.797	46.0	
Gas oil	10.5	.825	40.0	
Nonviscous lubricating distillate	9.5	.835–.856	38.0–33.8	50–100
Medium lubricating distillate	3.6	.856–.867	33.8–31.7	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	17.8	.882	28.9	
Distillation loss	.4			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 51018

IDENTIFICATION

Muddy Creek field	Willis M. Ruby	Pennsylvania
Berea sand, Mississippian	No. 26 Daniel Shanor	Butler County, Franklin Twp.
928–946 feet		Zelienople Quadrangle

GENERAL CHARACTERISTICS

Specific gravity, 0.800 A.P.I. gravity, 45.4°
Sulfur, percent, less than 0.1
Saybolt Universal viscosity at 100°F., 39 sec.
Pour point, °F, below 5
Color, N.P.A. No. 7

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 760 mm. Hg.
First drop, 49°C. (120°F.)

Fraction No.	*Cut at* *°C.*	*°F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I., 60°F.*	*C.I.*	*Aniline point, °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
1	50	122								
2	75	167	0.6	0.6						
3	100	212	1.3	1.9	0.709	68.1	—	63.8		
4	125	257	3.4	5.3						
5	150	302	7.4	12.7	.734	61.3	11	65.2		
6	175	347	8.9	21.6	.749	57.4	12	68.0		
7	200	392	8.7	30.3	.763	54.0	12	72.1		
8	225	437	7.5	37.8	.777	50.6	13	75.8		
9	250	482	8.1	45.9	.789	47.8	13	79.8		
10	275	527	9.9	55.8	.800	45.4	14	83.8		
STAGE 2—Distillation continued at 40 mm. Hg.										
11	200	392	3.8	59.8	0.812	42.8	16	87.0	39	20
12	225	437	8.4	68.0	.822	40.6	17	90.8	42	35
13	250	482	6.7	74.7	.831	38.8	18		51	55
14	275	527	5.0	79.7	.841	36.8	19		68	70
15	300	572	5.0	84.7	.851	34.8	21		100	80
Residuum			14.7	99.4	.884	28.6				

Carbon residue of residuum, 1.1 percent; carbon residue of crude, 0.2 percent.

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	1.9	—	—	
Total gasoline and naphtha	30.3	0.742	59.2	
Kerosene distillate	25.5	.790	47.6	
Gas oil	14.6	.820	41.1	
Nonviscous lubricating distillate	11.8	.830–.851	39.0–34.8	50–100
Medium lubricating distillate	2.5	.851–.856	34.8–34.0	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	14.7	.884	28.6	
Distillation loss	.6			

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REPORT OF CRUDE PETROLEUM ANALYSIS

Bureau of Mines Bartlesville Laboratory

Sample 48022

IDENTIFICATION

Rockdale field	F. R. Hagan et al.	Pennsylvania
Knox Third sand	A. H. Glasgow No. 1	Butler County, Penn. Twp.
Upper Devonian		Butler Quadrangle
1,616–1,638 feet		

GENERAL CHARACTERISTICS

Specific gravity, 0.795	A.P.I. gravity, 46.5°
Sulfur, percent, 0.83	Color, N.P.A. 7
Saybolt Universal viscosity at 100°F., 36 sec.	

DISTILLATION, BUREAU OF MINES ROUTINE METHOD

STAGE 1—Distillation at atmospheric pressure, 744 mm. Hg.
First drop, 32°C. (90°F.)

Fraction No.	*Cut at °C.*	*Cut at °F.*	*Percent*	*Sum, Percent*	*Sp. Gr., 60/60°F.*	*°A.P.I. 60°F.*	*C.I.*	*Aniline Point °C.*	*S.U. Visc., 100°F.*	*Cloud test, °F.*
1	50	122	1.2	1.2	0.652	85.5	—	60.4		
2	75	167	2.6	3.8						
3	100	212	5.7	9.5	.699	70.9	11	61.4		
4	125	257	8.5	18.0	.724	63.9	14	59.7		
5	150	302	8.3	26.3	.742	59.2	15	60.5		
6	175	347	8.3	34.6	.758	55.2	16	63.3		
7	200	392	6.8	41.4	.770	52.3	15	69.9		
8	225	437	6.8	48.2	.782	49.5	15	73.1		
9	250	482	6.6	54.8	.794	46.7	16	77.3		
10	275	527	6.5	61.3	.807	43.8	17	80.7		
STAGE 2—Distillation continued at 40 mm. Hg.										
11	200	392	2.9	64.2	0.821	40.9	20	85.0	41	20
12	225	437	5.8	70.0	.831	38.8	21	90.0	44	35
13	250	482	4.6	24.6	.834	37.8	20	93.4	52	50
14	275	527	4.7	79.3	.845	36.0	21	96.7	70	65
15	300	572	4.4	83.7	.857	33.6	24	102.5	105	70
Residuum			16.1	99.8	.891	27.3		123.0		

Carbon residue of residuum, 1.5 percent; carbon residue of crude, 0.3 percent

APPROXIMATE SUMMARY

	Percent	*Sp. Gr.*	*°A.P.I.*	*Viscosity*
Light gasoline	9.5	0.680	76.6	
Total gasoline and naphtha	41.4	0.732	61.8	
Kerosene distillate	19.9	.794	46.7	
Gas oil	9.7	.827	39.6	
Nonviscous lubricating distillate	10.0	.835–.856	38.0–33.8	50–100
Medium lubricating distillate	2.7	.856–.863	33.8–32.5	100–200
Viscous lubricating distillate	—	—	—	Above 200
Residuum	16.1	.891	27.3	
Distillation loss	.2			

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APPENDIX C

Selected shallow-well records from the Warren quadrangle

SELECTED WELL RECORDS—WARREN QUADRANGLE

	Section 2			Section 4	Section 5
Grid Location	G-2	C-10	D-9	E-10	F-8
Map Name of Well	V. Grandquist	Starbrick #3	H. White #1	D. Myers #5	State Hosp. B 19
Original Name of Well	D. Harrington	Gen. Concrete Prod. #2	Same	W. Ennis	Asylum #4
Operator	E. R. Tanner	Same	J. Sherrife	Craft	F. Crull
Date Completed	3/13/23	11/10/64	4/28/64		
Elevation	1248	1190	1570	1660	1230
Conductor (Drive Pipe)	265	85	20	20	
Surface Casing, Prod. Casing	317	270	400	274	
Pink Rock			450 –700		
Glade Sand	517–564	729–735	940–	1104–1121	530–550
Clarendon Stray Sand	588–594				
Clarendon Sand	625–637	826–850	1020–1060		
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Lewis Run	Clarendon	Gartland	Glade	Glade
Total Depth	1225	888	1108	1145	550
Remarks*	300 MCF (Cld) 1000 MCFGPD from Klondike Abd Gas	5 BO, 5 MCF Fractured Glade & Cld Oil	2 BO (Glade) Fractured Oil well	Glade oil	30 BO (Glade) Oil well

		Section 5			
Grid Location	F-9	F-9	F-9	F-9	F-10
Map Name of Well	Fitzger #1	Lots "D" #21	Lots "E" #19	Lots "H" #18	Biddle et al. #1
Original Name of Well	Uhl #1	Hertzel #21	Wade #19	Knowlton #18	Same
Operator	Craft	Hertzel	Grosch Bros.	Hertzel	B & C Oil Co.
Date Completed			11/6/62		
Elevation	1704	1648	1680	1509	1185
Conductor (Drive Pipe)			24		58
Surface Casing, Prod. Casing		360	455	320	174
Pink Rock			500–830		
Glade Sand	1102–	1065–1094	1075–1132	941–1226	650–688
Clarendon Stray Sand					
Clarendon Sand	1209–	1170–1190	1194–1226		
Gartland Sand					
Cherry Grove Sand	1352–				
Deepest Sand Penetrated	Cooper 1500–	Clarendon	Clarendon	Cherry Gove	Glade
Total Depth	1520	1200	1226	1200	714
Remarks	SG Cld & Cooper Glade Oil	Clarendon Oil	Fractured Glade & Clarendon Oil & Gas R.P. 50 psi	Glade Oil PB to 989	Glade Oil

* Production shown is initial production.

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 5

Grid Location	G-7	G-7	G-7	G-8	G-8
Map Name of Well	Sweeting #1	Klenck #2	E. Davies #24	State Hosp. B20	Fisher #1
Original Name of Well	Same	Klenck #2	Same	Crull B20	Same
Operator	Culbertson	Culbertson	E. Davies & Sons	G. Hazeltine	Paul A. Fisher
Date Completed	10/1944		7/12/63		1924
Elevation	1459	1304	1262	1230	
Conductor (Drive Pipe)	20	82	37		14
Surface Casing, Prod. Casing	205	220	217		140
Pink Rock			–270		
Glade Sand	708–732	595–616	530–588	500–	539–558
Clarendon Stray Sand					
Clarendon Sand			636–642	600–	649–659
Gartland Sand					
Cherry Grove Sand				720–	751–796
Deepest Sand Penetrated	Glade	Clarendon	Clarendon	Cooper 900–	Cherry Grove
Total Depth	759	692	655	900	796
Remarks	Shot SO Abd	30 BO (Glade)	70 BO (Glade & Clarendon) AF	Glade Oil Other sands showed oil	Glade Oil

Section 5

Grid Location	G-9	G-9	G-10	H-9	H-9
Map Name of Well	Warren High School #17	Beatty #1	Oakland Cem. #7	J. M. Hunter #3	D. Beatty #19
Original Name of Well	Rankin #17	Same	Same	F. Wentz #3	Beatty Farm
Operator	V. Weld	Beatty	L. Geer	F. Wentz	
Date Completed	1927	3/1875	5/10/63		1887
Elevation	1374	1217	1200	1780	1448
Conductor (Drive Pipe)	122	90	87	15	
Surface Casing, Prod. Casing			300	290	240
Pink Rock			–500	540–890	
Glade Sand	749–805	605–632	750–825	1120–1148	845–907
Clarendon Stray Sand					
Clarendon Sand	854–862		856–877	1237–1246	
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Glade	Clarendon	Clarendon	Glade
Total Depth	879	632	888	1300	927
Remarks	Glade Oil	5 BO (Glade)	Glade oil AF	Glade & Cld oil Shot Glade w/80 qts., shot Cld w/40 qts.	500 BO (Glade) After 60 days 400 BOPD

Section 5

Grid Location	H-9	H-9	H-10	H-10	H-10
Map Name of Well	Shaw #8	Shaw #24	Branch Est. #7	Warren Boro #5	Irvine #28
Original Name of Well	Same	Same	Eaton #7	S. Penfield	Same
Operator	Eaton O & G	Eaton O & G	Eaton O & G	Eaton O & G	L. Geer
Date Completed	1891	1920	1916		11/1958
Elevation	1493	1506	1636	1383	1260
Conductor (Drive Pipe)		62	30	19	115
Surface Casing, Prod. Casing		242	305	266	520
Pink Rock					–480
Glade Sand	900–	935–986	1081–1124	807–857	735–780
Clarendon Stray Sand					
Clarendon Sand	1025–	1052–1069	1189–1204	932–958	849–863
Gartland Sand					
Cherry Grove Sand		1163–1184			
Deepest Sand Penetrated	Clarendon	Bradford 3rd	Clarendon	Clarendon	Clarendon
Total Depth	1041	1557	1216	958	863
Remarks	Glade & Cld Shot both sands Prod. oil	Glade & Cld Shot both sands Prod. oil	18 BO (Glade)	Glade & Cld Oil well	Glade & Cld Shot both sands I.P. 10 BO

Section 5

Grid Location	I-6	I-8	I-9	I-9	I-9
Map Name of Well	L. Harmon #2	R. Guthrie #23	E. Abplanalp #25	U.S. Lumb. #2	U.S. Lumb. #2A
Original Name of Well	Same	P. Keller #23	Same	Same	Lohman
Operator	L. Harmon		W. Streich	Same	Chapman
Date Completed			11/15/63	8/19/63	1944
Elevation	1490	1640	1700	1760	
Conductor (Drive Pipe)		35	24	40	20
Surface Casing, Prod. Casing		233	343	435	394
Pink Rock	–460		545–730	–895	550–900
Glade Sand	665–730	960–1002	1040–1070	1158–1202	1140–1184
Clarendon Stray Sand					
Clarendon Sand	807–830	1065–1085	1145–1155	1273–1287	1254–1269
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	844	1101	1174	1332	1269
Remarks	150 MCF (Glade) R.P. 100 psi AF Abd	Glade & Cld Shot both sands Oil well	6 BO, R.P. 28 psi Glade & Cld Prod. AF	40 BO, Glade & Clarendon AF	Glade & Cld Oil AS

SELECTED WELL RECORDS—WARREN QUADRANGLE

	Section 5				
Grid Location	I-9	I-9	I-10	I-10	I-10
Map Name of Well	H. Kylander #11	G. Merchant #14	H. Kylander #14	K. D. Sherry #8	E. Lutz #14
Original Name of Well	Northrup #11	N. Larson #14	Northrup #14	K. D. Sherry #8	Lutz Est. #14
Operator	Chapman	R. Morrison	Chapman	K. D. Sherry	E. Smith
Date Completed		4/14/56	1938	1/1956	12/18/20
Elevation		1530	1701	1608	1611
Conductor (Drive Pipe)	38	40	17	23	23
Surface Casing, Prod. Casing	340	295	385	245	384
Pink Rock	580–930		550–900		
Glade Sand	1157–1211	985–1014	1127–1172	946–960	1080–1106
Clarendon Stray Sand				1003–1008	
Clarendon Sand	1276–1291	1100–1118	1245–1259	1041–1053	
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Glade
Total Depth	1305	1137	1264	1085	1112
Remarks	Glade & Cld Oil AS	6 BO (Cld) Shot w/60 qts.	Glade & Cld Oil AS	20 BO (Cld) AF	Glade Oil AS

	Section 5			Section 6	
Grid Location	I-10	J-8	J-10	K-10	K-10
Map Name of Well	M. Hull #19	L. Knoph #1	M. Schweitzer #1	J. Billstone #8	M. L. Hull #40
Original Name of Well	Cobham #19	Knoph #1	Chambers #1	Billstone G8	Reed #40
Operator	S.P.O. Co.	P. Keller	S.P.O. Co.	J. L. Thompson et al.	S.P.O. Co.
Date Completed	6/23/43	1896	4/19/43	10/16/45	8/30/43
Elevation	1827	1560	1711	1828	1496
Conductor (Drive Pipe)	43		34	48	22
Surface Casing, Prod. Casing	676		508	580	384
Pink Rock				726–1051	
Glade Sand	1341–1365	900–	Absent	1288 (shell)	Absent
Clarendon Stray Sand	1415–				
Clarendon Sand	1444–1463	1008–	1273–1295	1388–1398	1061–1080
Gartland Sand	1495–1508		1327–1345	1416–1465	1083–1104
Cherry Grove Sand					
Deepest sand Penetrated	Gartland	Clarendon	Gartland	Gartland	Gartland
Total Depth	1524	?	1364	1479	1123
Remarks	Gartland oil AS	Glade oil	2.5 BO AS w/50 qts. in Gartland	2 BO, 100 MCFG AS (Gartland)	Gartland oil AS

Section 6

Grid Location	K-10	L-7	L-7	L-7	L-8
Map Name of Well	M. L. Hull #95	M. O. Knupp "A" #1	G. T. Madigan #3	M. L. Miller #1	Warrant 5546
Original Name of Well	Lockwood #95	A. O'Neil #1	W. J. Knupp #3	Same	Same
Operator	S.P.O. Co.	V. A. Billstone	V. A. Billstone	V. A. Billstonc	Pennzoil Co.
Date Completed	11/30/48	11/19/37	10/1936	1/10/47	11/11/64
Elevation		2035	1965	2060	1820
Conductor (Drive Pipe)	5	32	55	17	31
Surface Casing, Prod. Casing	350	330	250	369	447
Pink Rock	-794				-1005
Glade Sand	1019–1024	1270–1315	1190–1230	1276–1310	1232–1248
Clarendon Stray Sand	1107–1125				
Clarendon Sand	1126–1148	1361–1394	1295–1305	1380–1388	1325–1350
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Lewis Run	Clarendon	Bradford 3rd
Total Depth	1180	1454	2000	1418	1803
Remarks	2.5 BO (Cld) AS	1,500 MCFG (Cld) Shot Glade & Clarendon	Clarendon oil AS	12 BO, Glade and Clarendon AS	Dry Abd

Section 6

Grid Location	L-9	L-10	L-10	L-10	L-10
Map Name of Well	Arm. For. #43	Lockwood #01	Lockwood #96	All. Nat. For. #24	All. Nat. For. #28
Original Name of Well	Reed #43	Same	Same	Mead #24	Mead #28
Operator	Pennzoil Co.	S.P.O. Co.	S.P.O. Co.	S.P.O. Co.	Pennzoil Co.
Date Completed	9/19/63	1929	1/7/49		6/28/63
Elevation	1831	1384			1696
Conductor (Drive Pipe)	35		23		23
Surface Casing, Prod. Casing	561		342		382
Pink Rock	640–990		-840		585–927
Glade Sand	1228–1236		1078–	1249–1254	1150–1158
Clarendon Stray Sand		951–965	1165–1185		
Clarendon Sand	1322–1342	966–996	1186–1205	1360–1387	1257–1284
Gartland Sand	1385–1411				
Cherry Grove Sand					
Deepest Sand Penetrated	Gartland	Clarendon	Clarendon	Lewis Run	Clarendon
Total Depth	1430	1003	1244	2001	1295
Remarks	Dry Abd	Water Intake Clarendon	1.5 BO (Cld) AS w/125 qts.	Clarendon oil AS, PB to 1421	Cored-capped

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 6

Grid Location	M-6	M-7	M-7	M-8	M-9
Map Name of Well	K. Sorenson #1	W. McMillen "A" #2	Hammermill #5	J. G. Hays #1	Arm. For. Co. #6
Original Name of Well	V. Lesh #1	War. A & T Co. #2	H. Walker #5	L. Gould #1	Smith #6
Operator	V. A. Billstone	V. A. Billstone	V. A. Billstone	V. A. Billstone	S.P.O. Co.
Date Completed	10/13/48	1916		8/11/49	
Elevation	1950	1842	1820	1600	1700
Conductor (Drive Pipe)	49	32	45	34	
Surface Casing, Prod. Casing	318	268	355	416	
Pink Rock		520–840			
Glade Sand	1133–1185	1064–1117	1068–1085	804	1120–1165
Clarendon Stray Sand					
Clarendon Sand	1226–1250	1178–1223	1171–1187		1272–1315
Gartland Sand		1245–			
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Haskill	Clarendon	Glade	Clarendon
Total Depth	1274	2500	1087	805	1339
Remarks	SO Glade & Cld Abd	Cld gas AS	9.5 BO (Cld)	2,500 MCFG (Glade)	Clarendon oil AS

Section 6

Grid Location	M-10	M-10	M-10	N-10	N-10
Map Name of Well	Harmon Is. #1	All. Nat. For. #13	All. Nat. For. #29	All. Nat. For. #7	All. Nat. For. #K842
Original Name of Well	Same	Mead #13	Mead #29	Mead #7	Jamison #K842
Operator	S.P.O. Co.	S.P.O. Co.	Pennzoil	S.P.O. Co.	Jamison
Date Completed	1901		8/7/63	1889	
Elevation	1202	1267	1897	1369	1302
Conductor (Drive Pipe)	83	58	50		
Surface Casing, Prod. Casing	373	458	442		
Pink Rock			770–1105		175–560
Glade Sand				790–	
Clarendon Stray Sand	719–	778–		879–919	838–874
Clarendon Sand	734–	809–	1450–1497		
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Cherry Grove	Clarendon Sty.	Cherry Grove
Total Depth	778	834	1575	919	964
Remarks	Oil & gas from both sands	Oil & gas from both sands	Cored-capped	Gas from both sands	Cld Sty gas

Section 6

Grid Location	N-10	O-7	O-8	O-9	O-10
Map Name of Well	All. Nat. For. #1	Ganyodio #3	Ganyodio #1	Wt 5555 #2	B. Brownell #1
Original Name of Well	Clark et al. #1	Hodge Run	Neil et al. #1	Same	Blair #1
Operator	S.P.O. Co.	R. J. Brennan	R. J. Brennan	Pennzoil	John Blair
Date Completed	1902		4/29/44	10/27/64	
Elevation	1921	1604	2013	2016	1264
Conductor (Drive Pipe)		15	20	18	40
Surface Casing, Prod. Casing		214	364	447 –1155	250 –458
Pink Rock		500–850	830–1175		
Glade Sand		Shells	1404–1425	1350–1400	
Clarendon Stray Sand	1450–1482		1477–1498		
Clarendon Sand		Shells	1498–1513	1474–1536	788–816
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Gartland	Cooper	Bradford 3rd	Cooper	Klondike
Total Depth	1544	1500	2021	1809	1152
Remarks	Cld Sty gas 300 Psi R.P.	Dry Abd	Dry Abd	Dry Abd	Dry Abd

Section 7

Grid Location	A-13	A-13	B-12	B-15	C-11
Map Name of Well	S. Gonzales #3	Lot 482 #1	All. Nat. For. #2	Lot 546 #1	Lot 444 #1
Original Name of Well	Lot 480 #1	P. Liberty #1	Lot 451 #2	Tom Bright #1	Barnum et al. #1
Operator	Chadequin Oil		N. Penn Oil Lands	Tom Bright	King
Date Completed	1933		8/1938	1917	1886
Elevation	1778	1754	1739	1567	1296
Conductor (Drive Pipe)	40	30	27	40	
Surface Casing, Prod. Casing	185	302	275	304 –980	
Pink Rock	777–1132		560–1040		
Glade Sand	1358–1378	1352–1364	1275–1320	1190–1200	787–850
Clarendon Stray Sand					
Clarendon Sand	1478–1488	1461–1505	1425–1450	1290–1317	853–913
Gartland Sand	1553–1588				
Cherry Grove Sand				1387–1395	
Deepest Sand Penetrated	Gartland	Cooper	Clarendon	Cooper	Upper Kane
Total Depth	1596	1820	1450	1639	1586
Remarks	15 MCF (Warren 2nd) Abd	Dry Abd	Glade Oil	SO Clarendon Abd	SO Cooper at 1120–1213 Abd

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 7

Grid Location	C-13	D-11	D-12	D-13	D-13
Map Name of Well	Lot 476 #1	Schmonsky #1	J. G. Pratt #17	Lot 486 #8	Lot 486 #024
Original Name of Well	L. E. Watson #1	Same	Sill Run #17	Same	Same
Operator	Dunham Oil Co.	J. L. Schmonsky	S. E. Kapp	D. W. Franchot	D. W. Franchot
Date Completed	1929	2/27/27		6/16/26	8/16/62
Elevation	1860	1181	1360	1843	1860
Conductor (Drive Pipe)			43	33	42
Surface Casing, Prod. Casing			560	553	540
Pink Rock	840–1190				820–1170
Glade Sand	1389–1453	677–708	902–938	1417–1446	1420–1450
Clarendon Stray Sand	1515–1545				
Clarendon Sand	1545–1566	776–795	1022–1038	1524–1529	
Gartland Sand			1085–		
Cherry Grove Sand	Shell		1130–1140		
Deepest Sand Penetrated	Cooper	Clarendon	Cherry Grove	Clarendon	Glade
Total Depth	1881	795	1160	1534	1462
Remarks	Dry Abd	Glade Oil	Glade & Cld Oil	Glade Oil AS	100 BO (Glade) AF

Section 7

Grid Location	D-14	E-11	E-11	E-12	E-12
Map Name of Well	Lot 507 #10	B. R. Owens #1	P. Hertzel #1	H. Moll #8	Carter #7
Original Name of Well	J. B. Haddon #10	Same	Same	Gern #8	Lauffenburger #7
Operator	J. B. Haddon	B. R. Owens	H. A. Hertzel	Geo. Gern	Paul Mead
Date Completed		5/7/14			
Elevation	1723	1180	1617	1401	1800
Conductor (Drive Pipe)	24	65	18	36	42
Surface Casing, Prod. Casing	445	458	273	360	221
Pink Rock					
Glade Sand	1304–1340	675–720	1149–1174	942–970	1342–1368
Clarendon Stray Sand					
Clarendon Sand	Absent	790–794		1055–1070	1463–1482
Gartland Sand					
Cherry Grove Sand					1600–shell
Deepest Sand Penetrated	Clarendon	Clarendon	Cherry Grove	Clarendon	Cherry Grove
Total Depth	1456	809	1383	1080	1622
Remarks	Glade Oil AS	Glade Oil, after 58 qt. shot, PB to 728	O & G (Glade) R.P. 25 psi.	Glade & Cld Oil	Glade & Cld Oil

Section 7

Grid Location	E-13	E-13	E-13	E-14
Map Name of Well	Lot 488 #1	Lot 488 #013	Lot 487 #21	Lot 504 #2
Original Name of Well	Same	Same	Same	Schofield et al. #2
Operator	D. W. Franchot	D. W. Franchot	B. Mead	L. M. Hare
Date Completed		6/1962		
Elevation	1567	1594	1612	
Conductor (Drive Pipe)	54		60	11
Surface Casing, Prod. Casing	279	390	360	295
Pink Rock		548–900	580–940	1148–1210
Glade Sand	1122–1183	1142–1205	1180–1217	
Clarendon Stray Sand	1189–1200		1227–1239	1260–1278
Clarendon Sand		1237–1267	1269–1288	
Gartland Sand	1258–			
Cherry Grove Sand	1330–1370	1356–		
Deepest Sand Penetrated	Bradford 3rd	Cherry Grove	Clarendon	Gartland
Total Depth	1705	1388	1290	1328
Remarks	25 BO (Glade) Abd 1886	8 BO (Glade & Cld)	Glade & Cld Sty Oil	O & G (Glade) PB to 1228

Section 8

Grid Location	F-11	F-11	F-12	F-13	F-13
Map Name of Well	I. Yeager #5	H. Peterson #1	Zimmerman #1	Lot 472 #9	Klenek #1
Original Name of Well	C. A. Cole #5	Same	Same	Buhl #40	Buhl #7
Operator	Leyandecke #5	Pierce et al.	Eldred Oil Co.	Buhl Bros.	Buhl Bros.
Date Completed	1935	9/25/63	2/4/64		
Elevation		1620	1845	1597	1484
Conductor (Drive Pipe)	119	30	42	30	50
Surface Casing, Prod. Casing	220	318	314	361	365
Pink Rock				555–885	
Glade Sand	775–798	1150–1173	1390–1426	1055–	1062–1190
Clarendon Stray Sand					
Clarendon Sand	879–896	1256–1272	1490–1517	1250–1274	1152–
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	899	1272	1547	1282	1169
Remarks	Glade Oil	20 BO (Glade) AF, RP 120 psi	7 BO (Glade) AF, Cld gas	Clarendon Oil	Glade & Cld Oil

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 8

Grid Location	F-13	G-11	G-12	G-12	G-13
Map Name of Well	Lot 490 #010	Gibson Oil Co. #4	Zimmerman #1	Lot 460 #22	Lot 470 #10
Original Name of Well	Same	Same	Same	Same	Buhl #10
Operator	D. W. Franchot	Gibson Oil Co.	V. Weld	G. R. Mead	Buhl Bros.
Date Completed	9/3/64		1920	3/6/64	
Elevation	1681	1626	1682	1470	1500
Conductor (Drive Pipe)	19	19		37	37
Surface Casing, Prod. Casing	557	319		264	440
Pink Rock	637–987			400–723	440–840
Glade Sand	1237–1288	1152–1180	1225–1270	968–1002	1050–1068
Carendon Stray Sand					
Clarendon Sand	1330–1354	1255–1273	1341–1359	1069–1089	1125–1170
Gartland Sand			1398–1404	1120–1125	1201–1219
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Cherry Grove	Gartland	Gartland	Gartland
Total Depth	1374	1380	1417	1125	1219
Remarks	Glade & Cld Oil AF	Glade & Cld Oil AS	Glade & Cld Oil AS	160 BO (Glade & Cld) AF	Glade & Cld Oil

Section 8

Grid Location	G-13	G-14	H-11	H-11	H-12
Map Name of Well	Hertzel #4	Dunham Oil Co. #1	F. H. Trax "2"	F. H. Trax "3, 4, 5" #24	Lot 461 #9
Original Name of Well	Same	Same	U.S. Gov. #1	Big Power #24	Duck #9
Operator	Stoneham Gas Co.	Dunham Oil Co.	Carl Starr	Carl Starr	Carl Starr
Date Completed		1929	9/17/62		
Elevation	1688	1519	1250	1734	1346
Conductor (Drive Pipe)	61	46	18		
Surface Casing, Prod. Casing	376	340	258		
Pink Rock		450–800	355–750		
Glade Sand	1178–1211	1040–1066	940–995	1243–1287	858–890
Clarendon Stray Sand					
Clarendon Sand	1302–1324	1140–1181	1040–1070	1346–1374	958–983
Gartland Sand				1402–1416	1002–1022
Cherry Grove Sand	1385–				
Deepest Sand Penetrated	Cherry Grove	Cherry Grove	Clarendon	Gartland	Haskill ?
Total Depth	1427	1300	1091	1433	2161 ?
Remarks	Glade & Cld Oil & gas	Clarendon gas & Oil	30 BO (Glade & Cld) AF	Gartland Oil	Gartland Oil

Section 8

Grid Location	H-12	H-13	H-13	H-15	I-11
Map Name of Well	Hanson #10	Hickey et al. #1	Lot 493 #5	Endeavor Lum. Co. #40	L. A. Johnston "A" #16
Original Name of Well	Same	Lot 468 #1	Same	Same	Bauer Est. #16
Operator	R. Hanson	Hickey & Russel	Steel	A. W. Goal	H. E. Anderson
Date Completed			1920		8/30/62
Elevation	1480	1817	1635		1353
Conductor (Drive Pipe)		19	45		111
Surface Casing, Prod. Casing		462	280	465	610
Pink Rock		740–1100	550–903		
Glade Sand	1002–1032	1300–1345			855–900
Clarendon Stray Sand		1428–1448	1220–1245		
Clarendon Sand	1111–1127	1462–1484	1245–1286	1495–	955–994
Gartland Sand	1151–1163				1025–1036
Cherry Grove Sand					
Deepest Sand Penetrated	Gartland	Clarendon	Haskill	Clarendon	Balltown
Total Depth	1172	1500	3400	?	1110
Remarks	Gartland Oil	Cld Sty & Cld O & G	Cld Sty & Cld O & G	Cld Oil	Fraced Gartland Plugged well

Section 8

Grid Location	I-11	I-11	I-12	I-12	I-14
Map Name of Well	M. Hull #22	Hertzell #15	Keenan #2	End. Lum. Co. #19	Kemp #28
Original Name of Well	Cobham #22	Same	Lot 462 #2	Mullin #19	Same
Operator	Pennzoil Co.	J. L. Billstone	W. E. Keenan	V. Weld	Crew Levick
Date Completed	10/19/63				
Elevation	1278	1247	1594	1556	1657
Conductor (Drive Pipe)	22		50		41
Surface Casing, Prod. Casing	396		275		361
Pink Rock	170–520			408–808	–915
Glade Sand	778–822	725–770		1046–1071	1148–1154
Clarendon Stray Sand	854–880			1111–1154	
Clarendon Sand	885–902	832–862	1211–	1155–1192	1265–1286
Gartland Sand	918–930	873–895			
Cherry Grove Sand					
Deepest Sand Penetrated	Gartland	Gartland	Clarendon	Clarendon	Clarendon
Total Depth	967	898	1237	1192	1305
Remarks	Dry & Abd	Cld Oil	Cld Oil	Cld Oil	Cld Oil

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 8

Grid Location	I-15	I-15	J-11	J-12	J-12
Map Name of Well	Lot 556 #35	Wolfs Head #34	Deacon #5	W. Egger #7	C. Hills #1
Original Name of Well	Same	Templeton #34	Same	Grossenburg #7	Same
Operator	S.P.O. Co.	S.P.O. Co.	Paul A. Fisher	C. V. Card	Jim Clark
Date Completed		1909		1933	
Elevation	1616	1630	1566	1301	1470
Conductor (Drive Pipe)	27			22	16
Surface Casing, Prod. Casing	337		335	213	245
Pink Rock				-540	
Glade Sand			1030–1064	776–801	945–
Clarendon Stray Sand			1130–	858–884	
Clarendon Sand	1272–1302	1284–1310	1164–	885–923	1086–1110
Gartland Sand					
Cherry Grove Sand	1402–1418	1410–1421			
Deepest Sand Penetrated	Cherry Grove	Cherry Grove	Clarendon	Clarendon	Clarendon
Total Depth	1434	1451	1202	923	1110
Remarks	Cld & Cherry G. Oil & G	Cld & Cherry G. Oil	Cld Oil	Cld Oil	Glade gas Cld oil

Section 8

Grid Location	J-12	J-13	J-13	J-13	J-14
Map Name of Well	Columbia Oil Co. #35	G. Walker #P1	Gilmore #1	Lot 496 #1	Bobray Ex. Co. #05
Original Name of Well	Ruhlman #35	Millspau #P1	Same	Easton Pet. Co. #1	Lot 79 #05
Operator	O. D. Ruhlman	Pennzoil Co.	?	S.P.O. Co.	Shaner Oil Co.
Date Completed		11/6/63	1942	1880	1/1941
Elevation	1317	1746	1341	1516	1389
Conductor (Drive Pipe)	152			81	56
Surface Casing, Prod. Casing	430	384	230	300	301
Pink Rock	-560	620–960	-590		313–645
Glade Sand	807–815	1207–1215	830–		880–885
Clarendon Stray Sand	875–	1298–1308	910–		
Clarendon Sand	908–	1317–1332	931–	1095–	987–1012
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Deerlick	Clarendon	Clarendon	Clarendon
Total Depth	950	1874	?	1147	1016
Remarks	Cld Oil	Cld Oil	Cld Oil	Cld Oil shot w/80 qts	Cld Oil

	Section 8		Section 9		
Grid Location	J-14	J-15	K-11	K-11	K-12
Map Name of Well	Cld. Prod. Co. #10	J. Kinley "A" #12	Verbeck Is. #2	Patterson #127	Lot 53 #117
Original Name of Well	Davis #10	Lot 558 #12	Same	Same	Luling #117
Operator	Crew Levick Co.	A. W. Goal	G. D. Templeton	Pennzoil Co.	Pennzoil Co.
Date Completed	12/1936		1908	12/27/63	6/9/64
Elevation	1372	1459	1178	1491	1654
Conductor (Drive Pipe)			24	27	47
Surface Casing, Prod. Casing		215	460	301	352
Pink Rock	279–624			260–730	540–875
Glade Sand	864–880				1110–1157
Clarendon Stray Sand				1048–1078	1189–1199
Clarendon Sand	969–1007	1068–1108	782–829	1078–1114	1199–1238
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	1026	?	?	1144	1330
Remarks	Clarendon oil	Clarendon oil	Clarendon oil show w/140 qts.	Dry Abd	Clarendon oil AF

	Section 9				
Grid Location	K-13	K-13	K-14	K-14	K-14
Map Name of Well	Lot 56 #104	Lot 78 #160	Lot 79 #16	Lot 80 #16	Lot 105 #CW2
Original Name of Well	Luling #104	Eastern Pet. #160	A. Robinson #5	Gallagher #16	Gallagher #CW2
Operator	Pennzoil Co.	Pennzoil Co.	S.P.O. Co.	Pet. Reclamation	Pet. Reclamation
Date Completed	1929	8/1919			9/17/34
Elevation	1581	1842	1647	1772	1713
Conductor (Drive Pipe)		28		20	37
Surface Casing, Prod. Casing		491		376	434
Pink Rock					560–887
Glade Sand	1050–1070				1132–
Clarendon Stray Sand	1106–1131				
Clarendon Sand	1135–1180	1378–	1206–1231	1346–1380	1232–1260
Gartland Sand				1424–1444	
Cherry Grove Sand				1478–1485	
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	1189	1407	1252	1497	1271
Remarks	Clarendon oil	Clarendon oil show w/80 qts.	Clarendon oil	Clarendon oil AS	Clarendon oil AS

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 9

Grid Location	K-15	K-15	K-15	L-11	L-11
Map Name of Well	Lot 108 #33	Lot 162 #4	Lot 163 #20	Patterson #128	Patterson #124
Original Name of Well	Same	Tiona #4	Tiona #20	Same	Same
Operator	D. W. Franchot	S.P.O. Co.	S.P.O. Co.	Pennzoil Co.	Pennzoil Co.
Date Completed				3/31/64	
Elevation	1738	1371		1867	1431
Conductor (Drive Pipe)		62	188	21	
Surface Casing, Prod. Casing	364	342	255	665	
Pink Rock				774–1105	
Glade Sand					
Clarendon Stray Sand				1395–1449	976–988
Clarendon Sand	1338–1370	975–1003	980–1010	1449–1488	995–1040
Gartland Sand					
Cherry Grove Sand	1447–1465		1084–1099		
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	1533	1043	1139	1504	1054
Remarks	Clarendon oil	Clarendon oil	Clarendon oil	Clarendon oil AF	Clarendon oil

Section 9

Grid Location	L-12	L-12	L-13	L-14	L-14
Map Name of Well	J. Funk #1	W. Streich #11	Lot 29 #33	Endeavor Lum. #28	Lot 104 #11
Original Name of Well	Keenan #1	Eagan #11	Same	Lot 81 #28	Armour #11
Operator	Keenan	Bright	Pennzoil Co.	S.P.O. Co.	D. W. Franchot
Date Completed			7/29/64		
Elevation	1466	1882	1888	1932	1902
Conductor (Drive Pipe)	24	20	40		28
Surface Casing, Prod. Casing	288	475	418	665	630
Pink Rock			765–1105		
Glade Sand					
Clarendon Stray Sand	1005–1030	1407–	1400–1430		
Clarendon Sand	1040–1069	1435–1474	1430–1480	1479–1502	1474–
Gartland Sand	1109–1114				
Cherry Grove Sand		1524–	1518–1528		
Deepest Sand Penetrated	Cherry Grove	Cherry Grove	Lewis Run	Clarendon	Clarendon
Total Depth	1158	?	2041	1528	1502
Remarks	Cld & Cld Stray Oil AS	Clarendon oil	Dry Abd	Clarendon oil	Clarendon oil

Section 9

Grid Location	L-15	L-15	M-11	M-12
Map Name of Well	Endeavor Lum. #5A	Lot 160 #K21	Clark et al. #4	Lot 38 #36
Original Name of Well	Dinsmore #5A	Six Mile Oil #K21	Same	Stoneham Gas #36
Operator	Pet. Reclamation	Pet. Reclamation	Pennzoil Co.	Stoneham Gas Co.
Date Completed			4/27/64	
Elevation	1483	1409	1900	1587
Conductor (Drive Pipe)	82	49	23	
Surface Casing, Prod. Casing	122	246,666	678	332
Pink Rock	351–693	350–660	975–1125	411–769
Glade Sand		916–		1015–
Clarendon Stray Sand			1435–1450	
Clarendon Sand	1041–1065	1002–1034	1450–1476	1107–1122
Gartland Sand				
Cherry Grove Sand				
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	1083	1034	1578	1150
Remarks	Clarendon oil	Clarendon oil	Clarendon oil AF	20 MCF (Cld) BS

Section 9

Grid Location	M-12	M-12	M-13	M-13	M-14
Map Name of Well	Lot 38 #38	M. Anderson #10	Lot 58 #13	Lot 75 #5	Wt 103 Lot 17 #15
Original Name of Well	Stoneham Gas #38	Lot 51 #10	Same	Same	Same
Operator	Stoneham Gas Co.	Stone Gas Co.	S.P.O. Co.	S.P.O. Co.	S.P.O. Co.
Date Completed					11/29/61
Elevation		1894	1910		1575
Conductor (Drive Pipe)	33	132			68
Surface Casing, Prod. Casing	300	479			382
Pink Rock	380–735				475–807
Glade Sand				1202–1242	1035–1045
Clarendon Stray Sand		1405–			
Clarendon Sand	1068–1090	1430–1460	1453–1495	1332–1358	1144–1170
Gartland Sand					
Cherry Grove Sand					
Deepest Sand Penetrated	Clarendon	Clarendon	Clarendon	Clarendon	Clarendon
Total Depth	1104	1478	1501	1378	1191
Remarks	Clarendon O & G	Clarendon oil	Clarendon oil	Clarendon oil	Clarendon oil

SELECTED WELL RECORDS—WARREN QUADRANGLE

Section 9

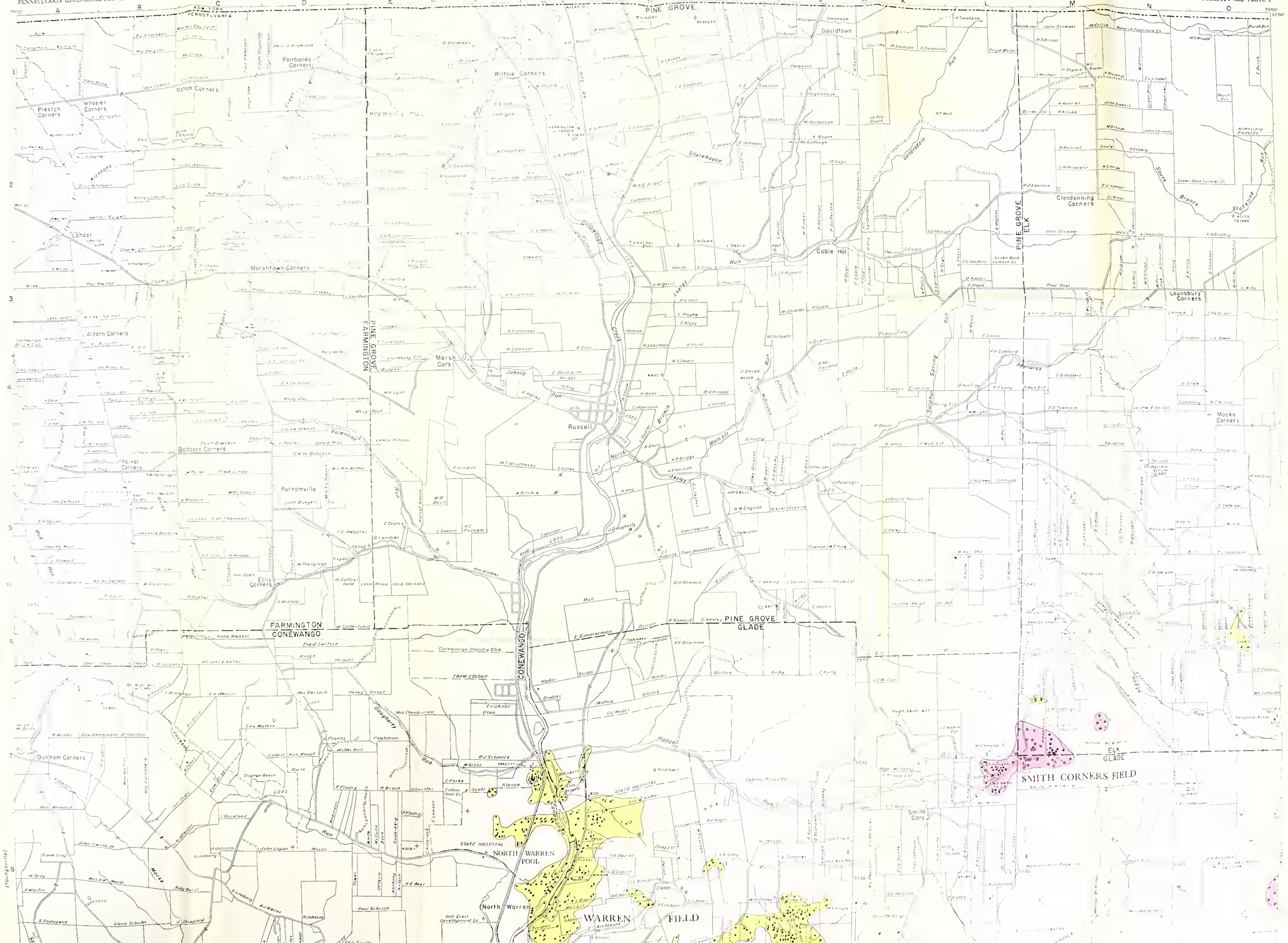
Grid Location	M-15	N-11	N-12	N-13	N-13
Map Name of Well	Lot 159 #7	Jamieson "B" #1	Lot 39 #3	Lot 59 #19	Lot 73 #3
Original Name of Well	Same	Jamieson #1	Same	Same	Same
Operator	S.P.O. Co.	Kinzua Chem. Co.	Stone Gas Co.	S.P.O. Co.	Streich Bros.
Date Completed				9/14/64	4/1930
Elevation	1666		1622	1979	1996
Conductor (Drive Pipe)			21	35	
Surface Casing, Prod. Casing	237		360	454	
Pink Rock				726–1176	
Glade Sand				1410–	
Clarendon Stray Sand			1114–		
Clarendon Sand	1267–1291	1300–1335	1134–1164	1517–1557	1533–1551
Gartland Sand					
Cherry Grove Sand				1600–1612	1661–1683
Deepest Sand Penetrated	Clarendon	Kane	Clarendon	Lewis Run	Cherry Grove
Total Depth	1305	2100	1172	2125	1691
Remarks	Clarendon oil	Clarendon oil	Clarendon oil	Dry & Abd	Clarendon oil AS

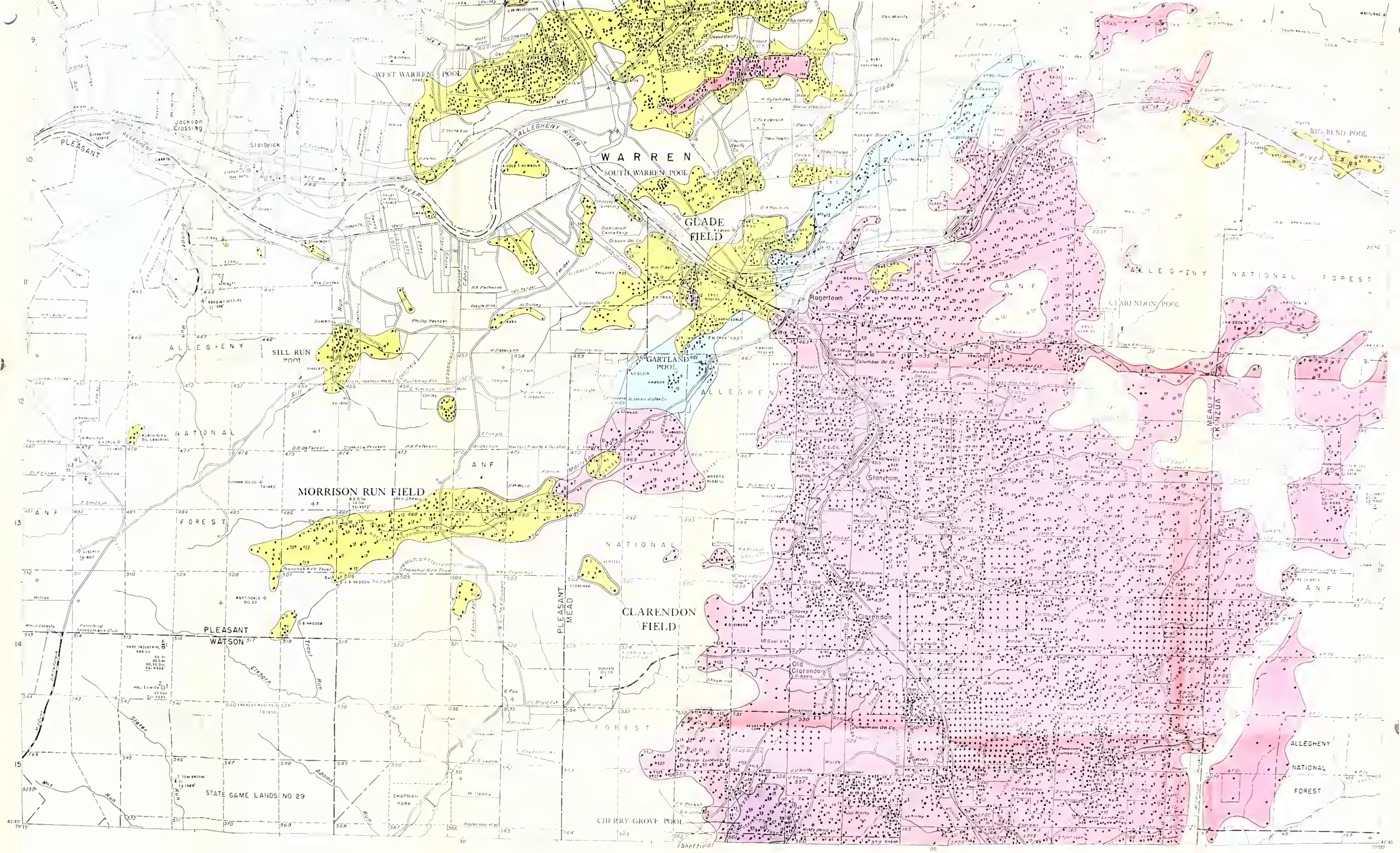
Section 9

Grid Location	N-14	N-14	O-12	O-12	O-13
Map Name of Well	Lot 83 #13	Lot 102 #9	Lot 40 #11	Anderson #6	Lot 60 #1
Original Name of Well	Clapp #13	Same	Bartholomeu #11	Lot 49 #6	Same
Operator	J. & W. Streich	S.P.O. Co.	Kinzua Chem. Co.	Lesser & Launer	Lesser & Launer
Date Completed		8/16/89			
Elevation	1975	1912	1877	1829	2006
Conductor (Drive Pipe)	42				190
Surface Casing, Prod. Casing	545	375	565	527	352
Pink Rock					
Glade Sand					
Clarendon Stray Sand					
Clarendon Sand	1522–1544	1485–1505	1416–1426	1371–1394	1544–1570
Gartland Sand				1451–1459	
Cherry Grove Sand	1640–1657				1663–1683
Deepest Sand Penetrated	Deerlick	Clarendon	Clarendon	Gartland	Cherry Grove
Total Depth	2060	1535	1442	?	?
Remarks	Clarendon oil shot w/55 qts.	Clarendon oil shot w/100 qts.	Clarendon gas was not shot	Clarendon oil	Clarendon oil

PENNSYLVANIA GEOLOGICAL SURVEY

BULLETIN M52, PLATE 1





EXPLANATION

●	Oil well (with record)
●	Abandoned oil well (no record)
●	Show of oil
✱	Gas well
✱	Abandoned gas well
✱	Show of gas
●	Oil and gas well
●	Abandoned oil and gas well
+	Dry hole
-	Well, no information
▲	Air input well
●	Water input well
◎	Deep well
G	Gas
SG	Show of gas
SO	Show of oil

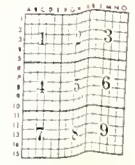
Gl	Glade
Cld St	Clarendon Stray
Cld	Clarendon
Ga	Gartland
CG	Cherry Grove
Cp	Cooper
Kd	Klondike
Dk	Deerlick
B3	Bradford Third
LR	Lewis Run
Sa	Sartwell
Dhm	Hamilton
Don	Onondaga
Dor	Oriskany
Sbi	Bass Island
Ss	Salina
Sl	Lockport
Sm	Medina
Oq	Queenston
Cg	Gatesburg

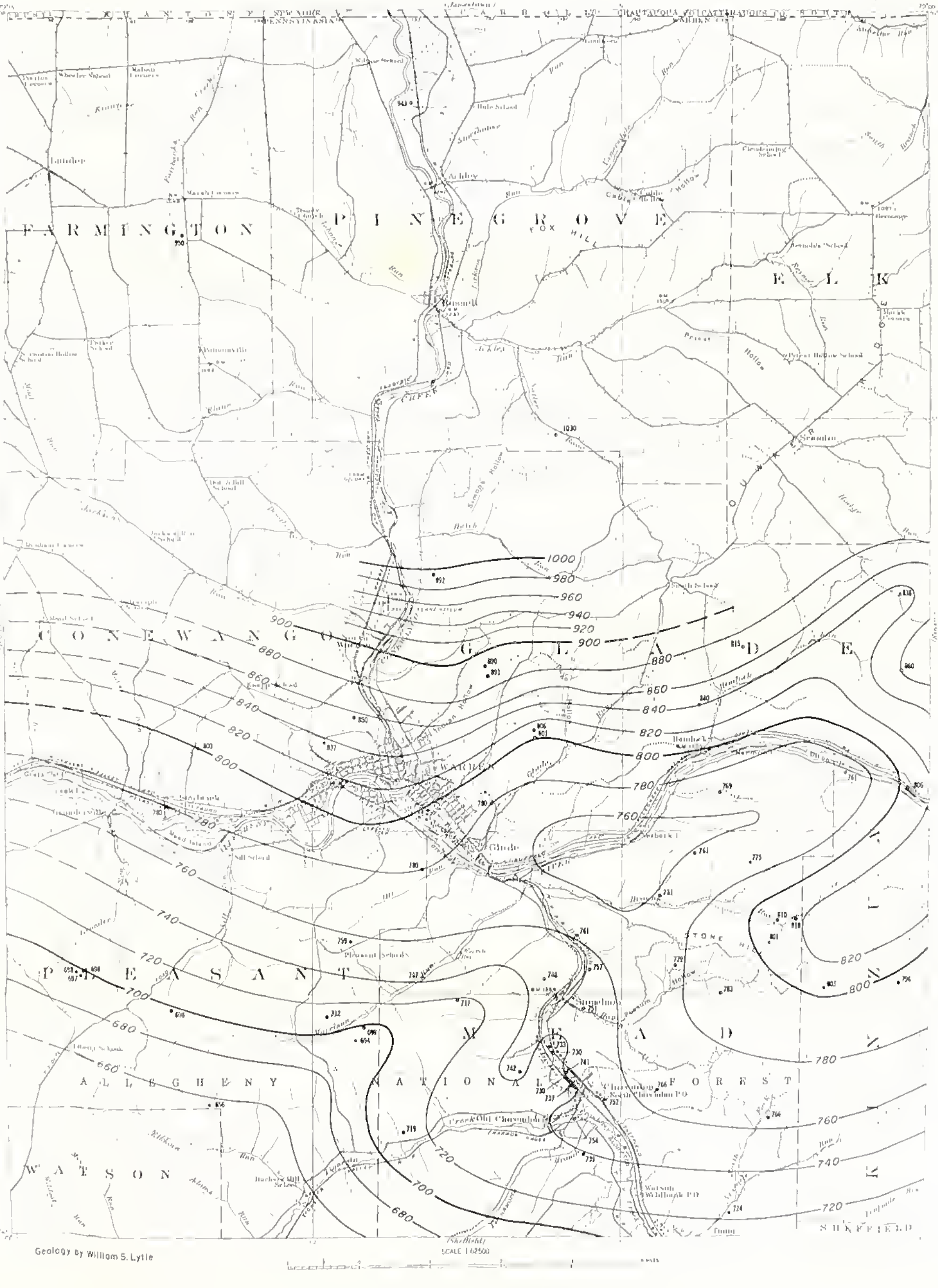
🟨	Productive area Glade Sand
🟨	Productive area Clarendon Stray Sand
🟪	Productive area Clarendon Sand
🟦	Productive area Gartland Sand
🟪	Productive area Cherry Grove Sand

Scale
0 2000 4000 6000 8000 10000 Feet
0 2 Miles

Geology by William S. Lytle
Drafted by L. A. Heeren

Plate 1. Oil and Gas Fields Map of the Warren Quadrangle, Pennsylvania





Geology by William S. Lytle

Plate 2. Subsurface contours on base of "Pink Rock"

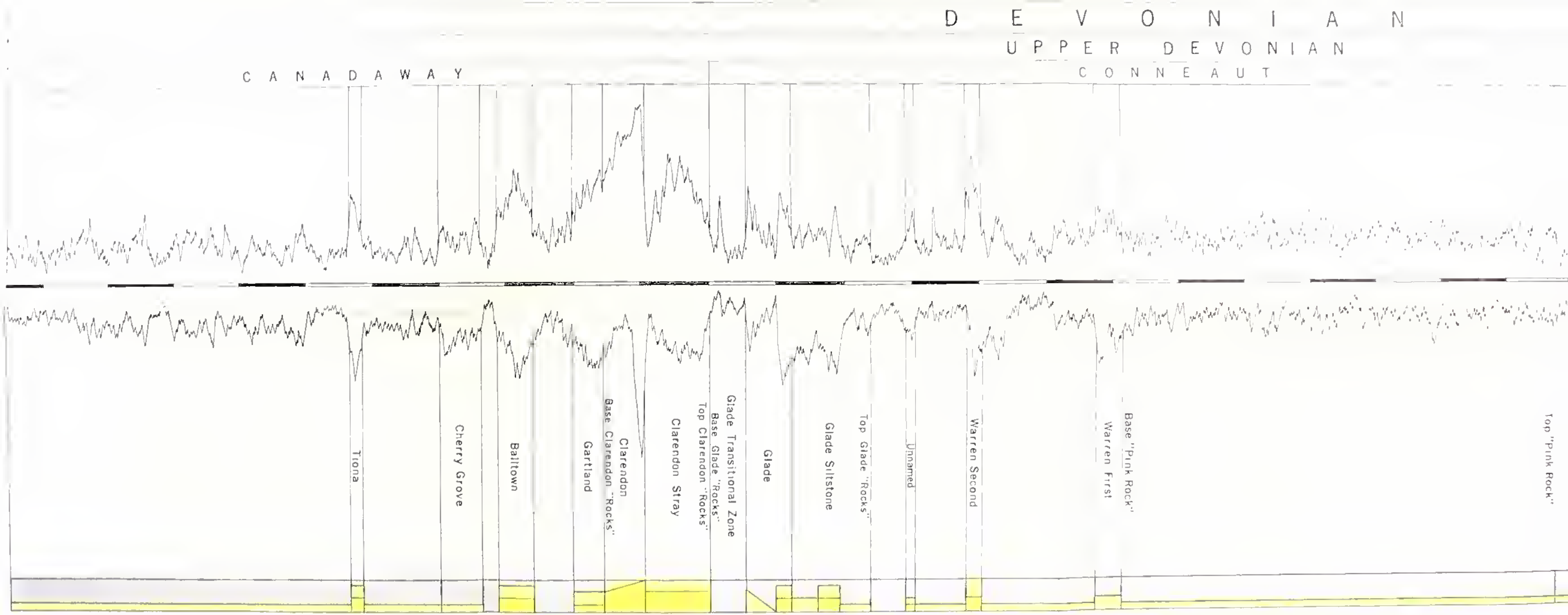
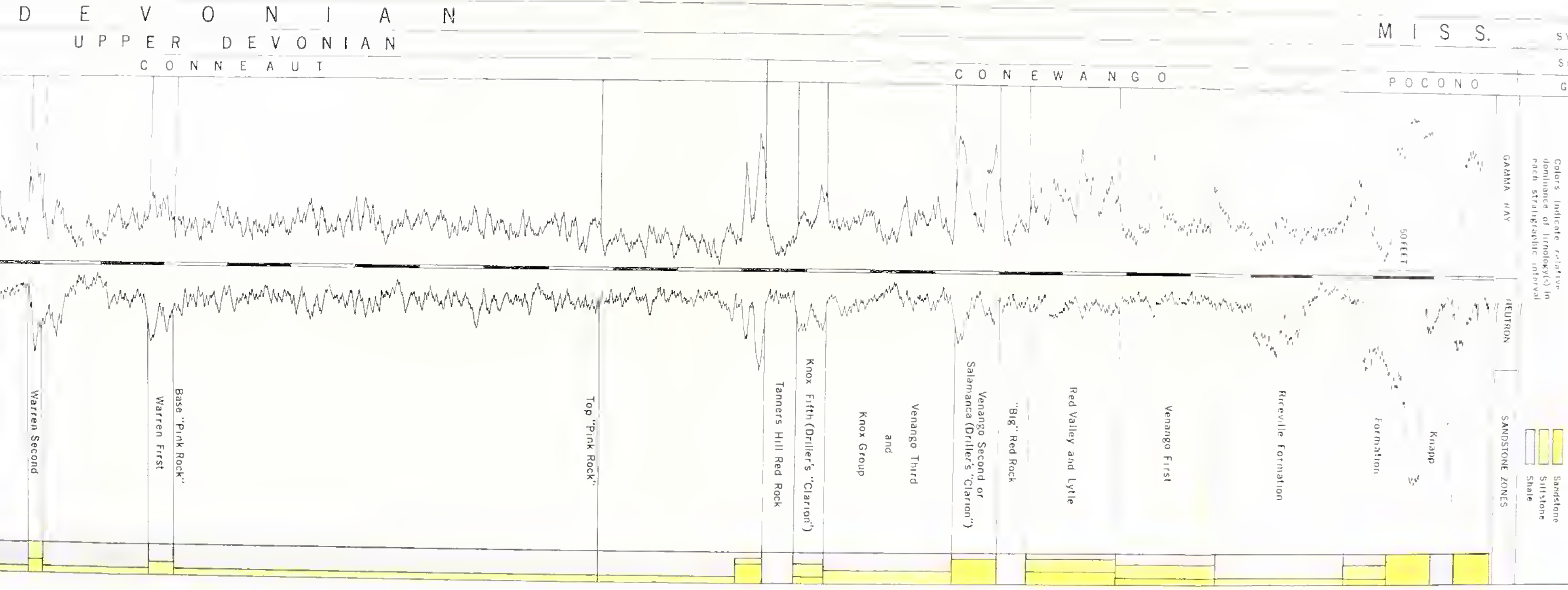


Plate 3. Typical subsurface stratigraphic section in the Warren quadrangle, Pennsylvania

TYPICAL SUBSURFACE STRATIGRAPHIC SECTION
WARREN QUADRANGLE, PA.

Ground Elevation 1845 Feet



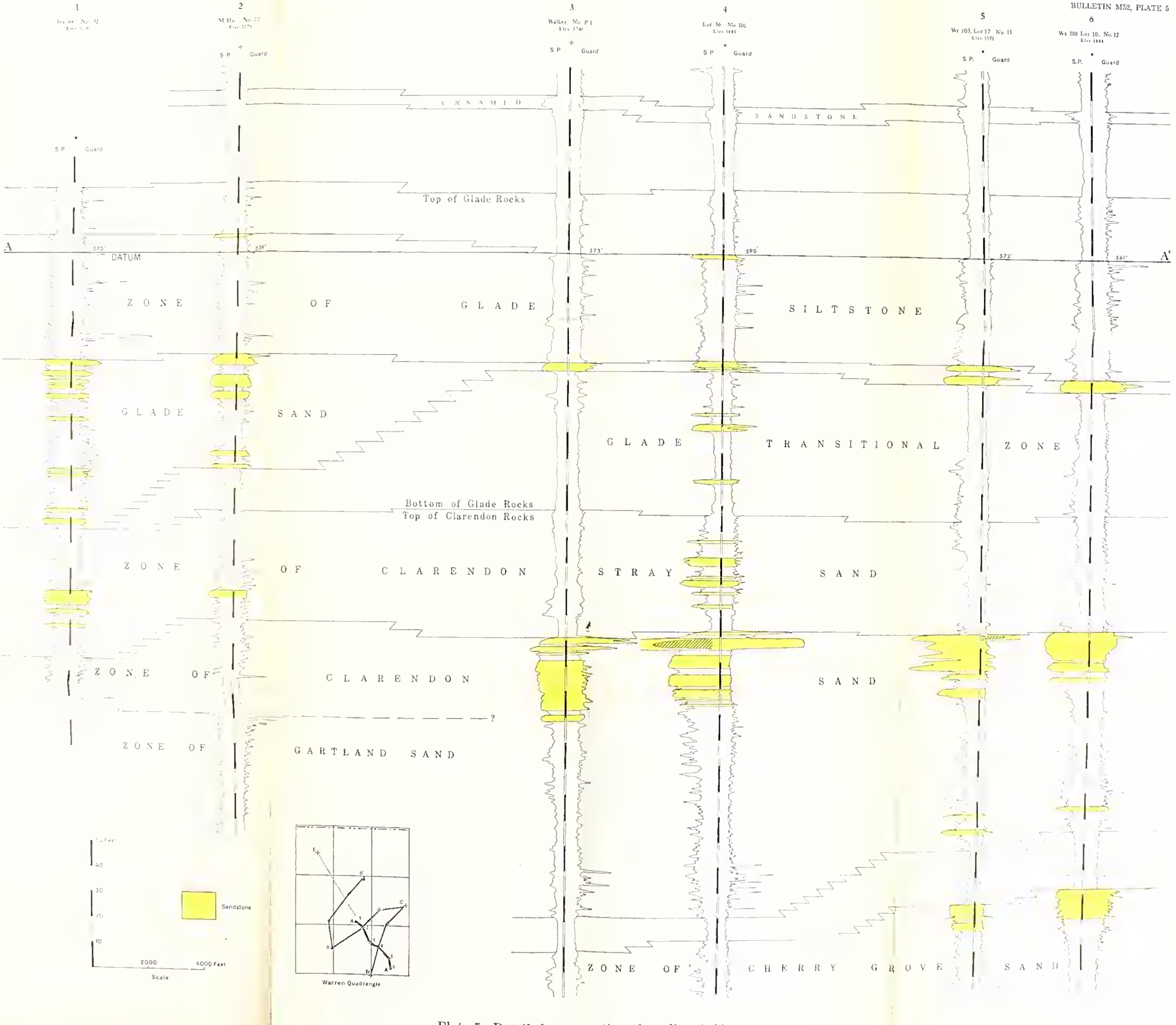


Plate 5. Detailed cross section along line A-A′

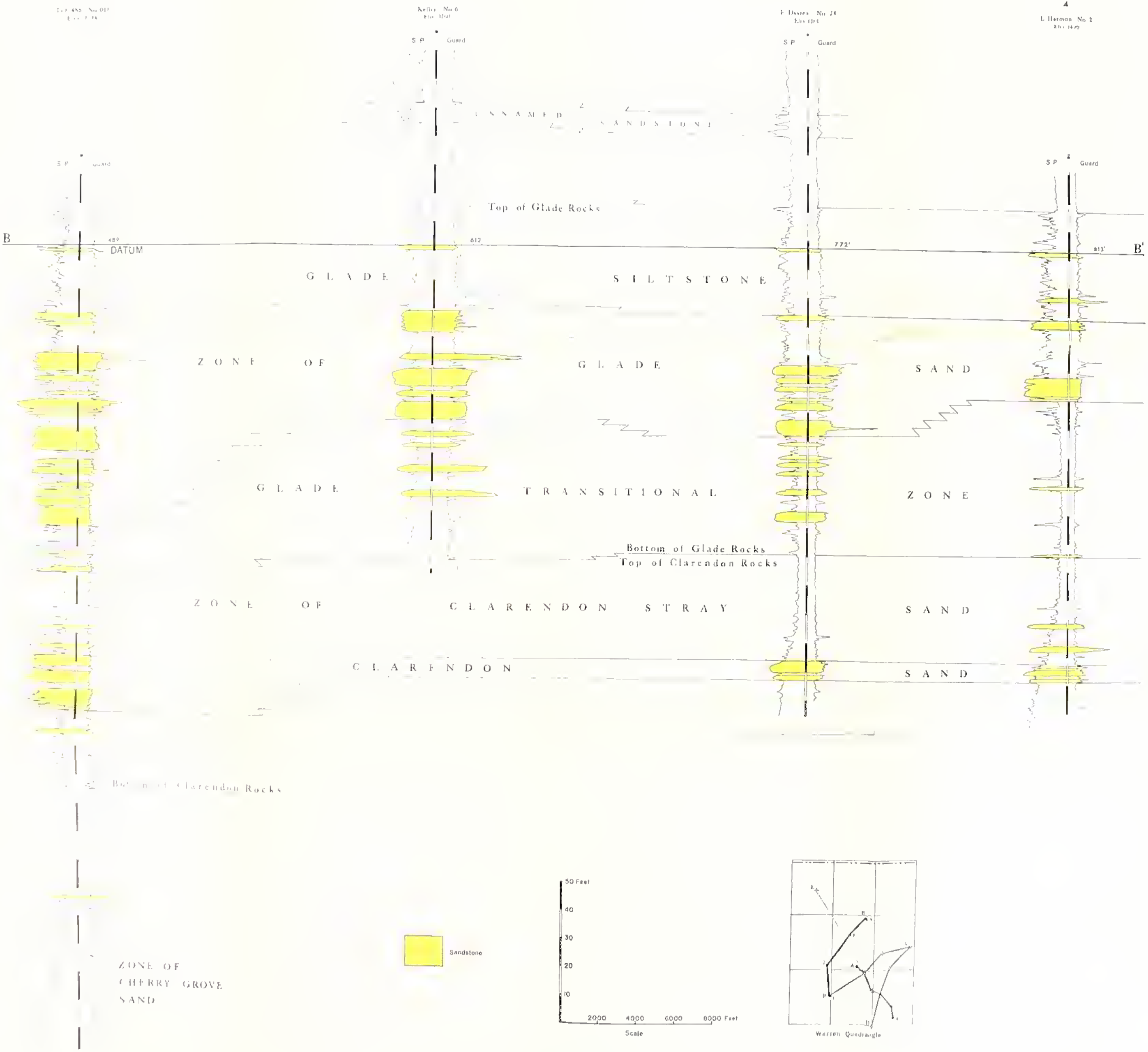


Plate 6. Detailed cross section along line B-B′

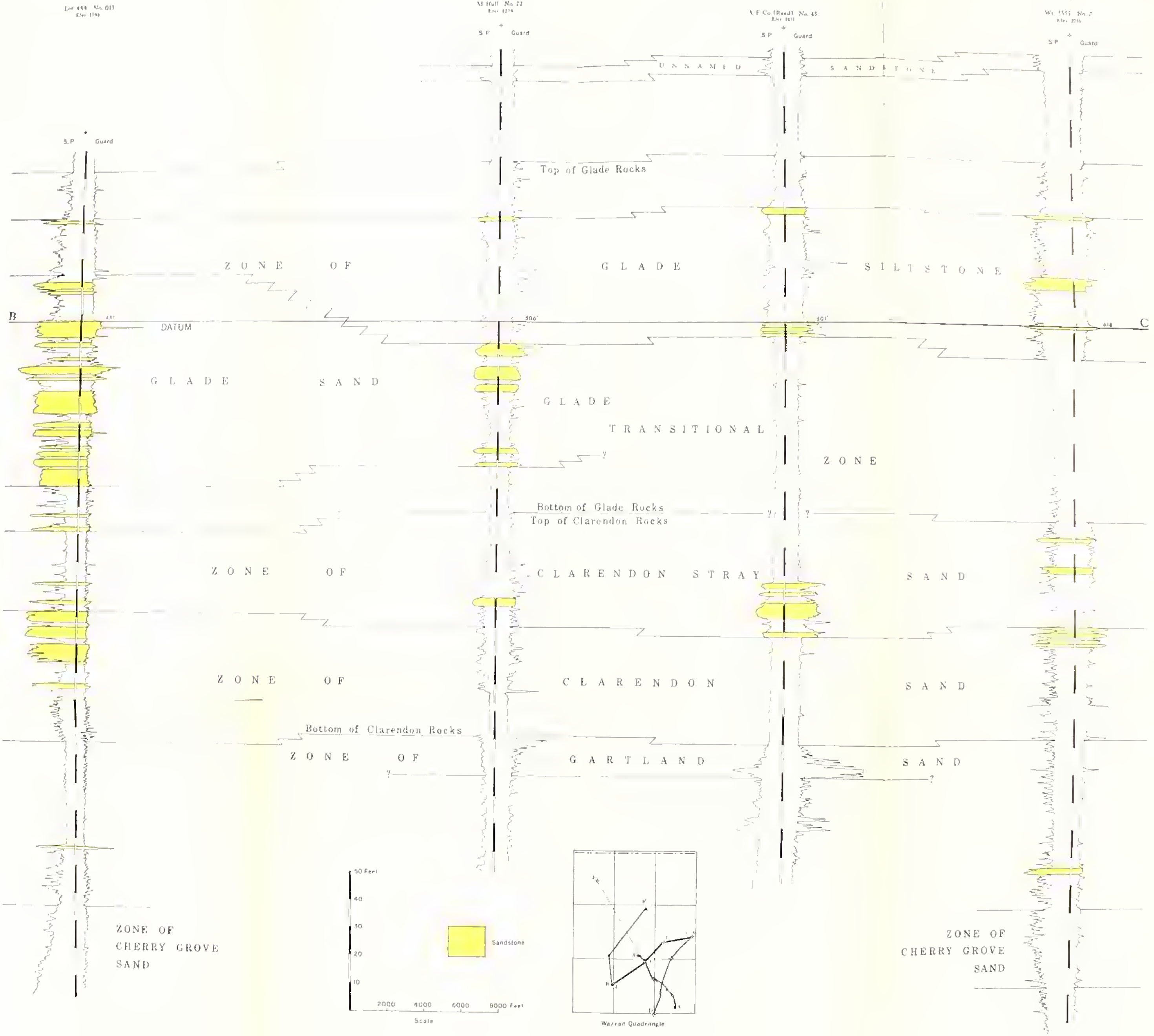


Plate 7. Detailed cross section along line B-C

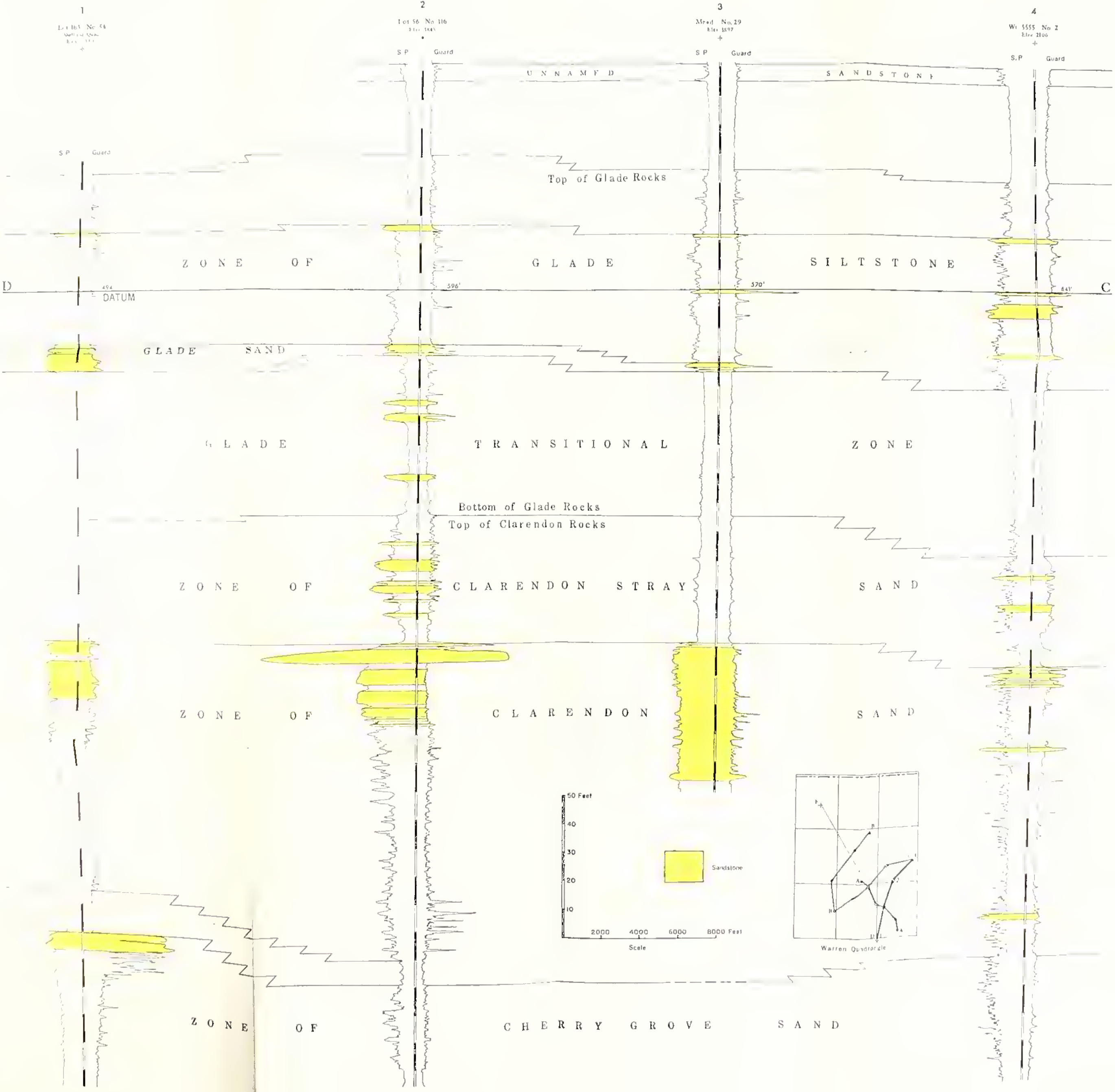


Plate 8. Detailed cross section along line D-C

PENNSYLVANIA GEOLOGICAL SURVEY

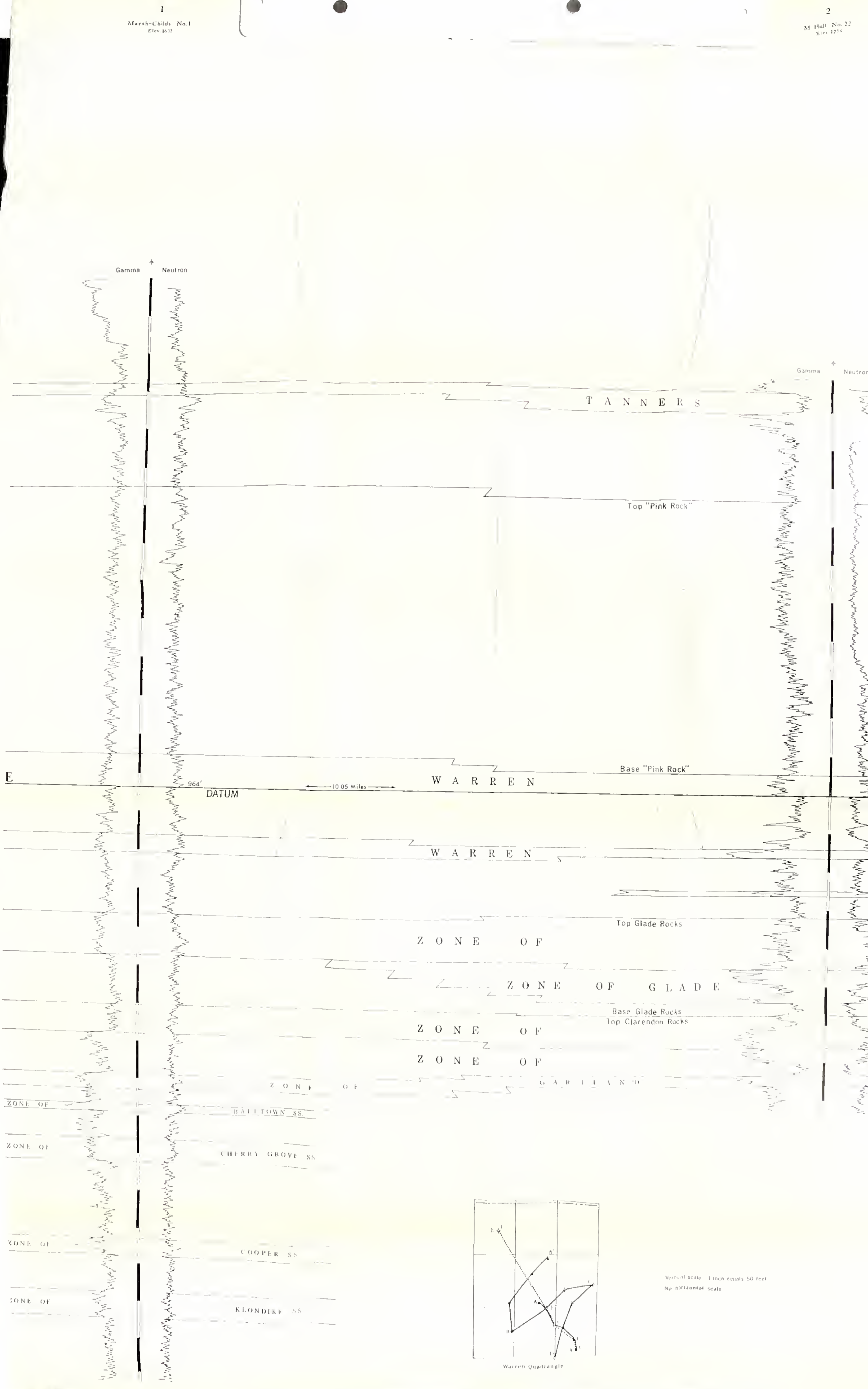


Plate 4. Full-

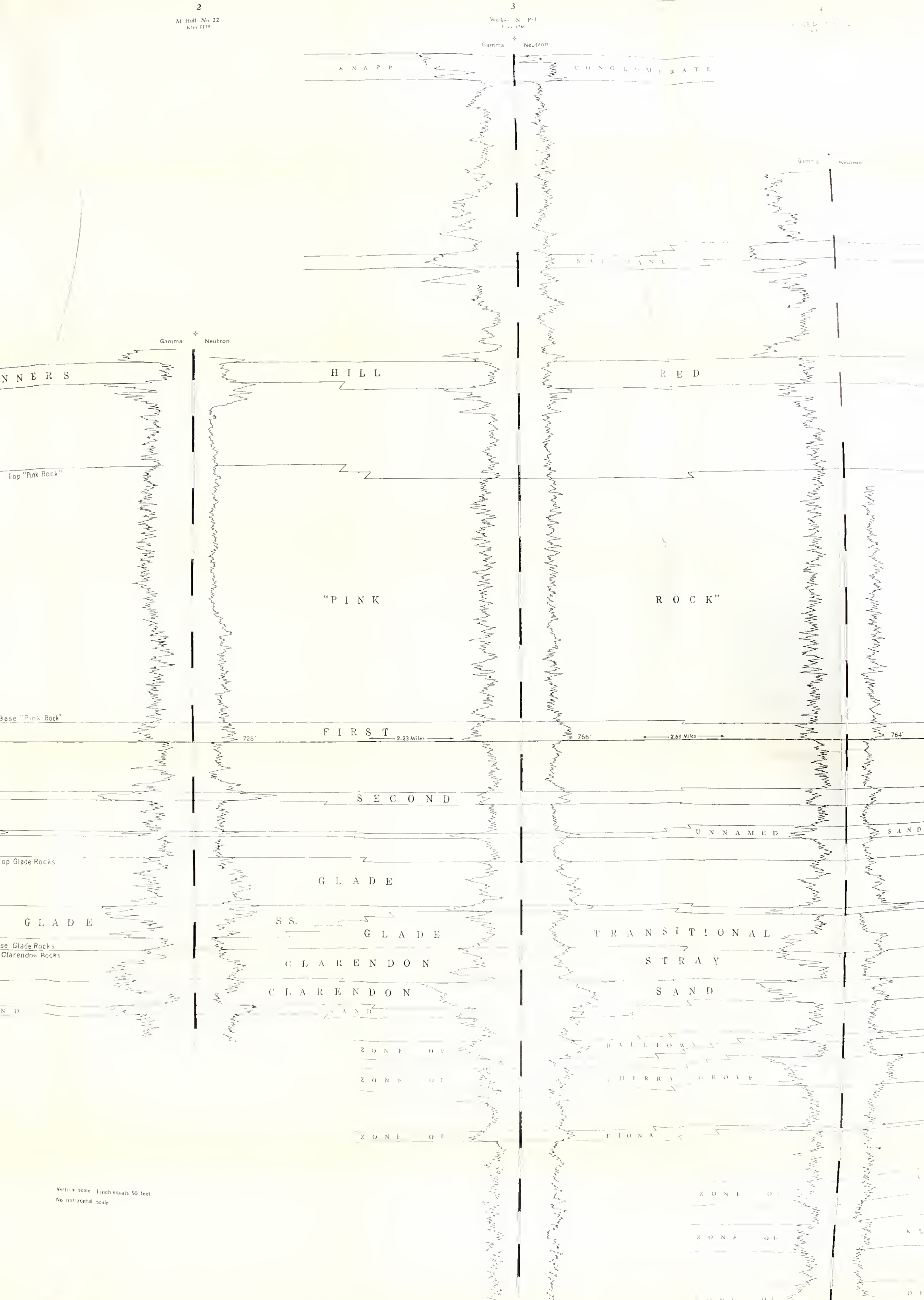
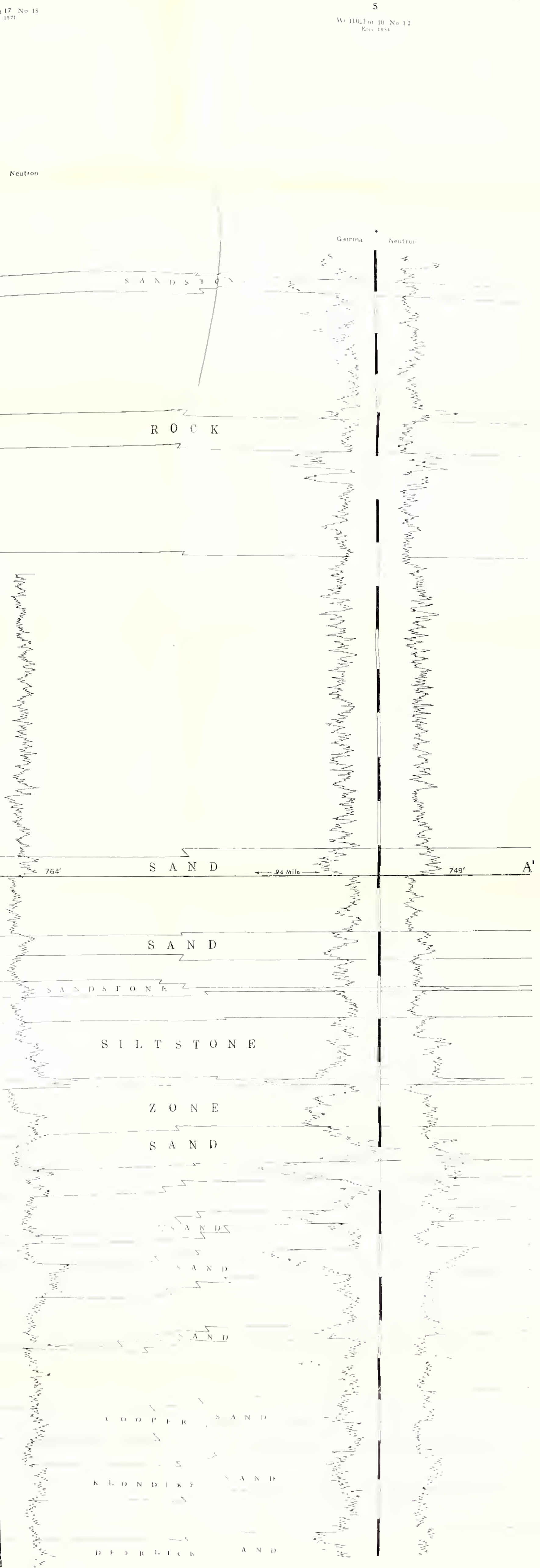


Plate 4. Full-hole cross section along line E-A'


4
17 No 15
1571
5
Wt 110-1 or 10 No 12
Elev. 1154
Neutron
Gamma
Neutron
SANDSTONE
ROCK
SAND
764'
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A'
SAND
SANDSTONE
SILTSTONE
ZONE
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SAND
COOPER SAND
KLONDIKE SAND
DEERLICK SAND